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RADC-TR-77-262
Final Technical Report
August 1977

DIGITAL REVISION TECHNIQUES

Synectics Corporation

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DIGITAL REVISION TECHNIQUES

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This report describes the feasibility of automated digital revision techniques for cartographic products. Evaluation was made of current cartographic software technology and cartographic hardware systems for utilization in automated revision processes. A software concept for automated revision as a batch editing process was designed and procedurally tested and evaluated. Conclusions reached as a result of this effort are set forth and recommendations made for further software development.

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EVALUATION

This technical report documents first steps in the effort to achieve a capability to revise digital cartographic products in a time, labor and resource efficient manner. The applicability of the results is to the Defense Mapping Agency and to other producers of highly complex, very accurate non-stylized graphic products from digital data. The results of this effort will form a basis for continued investigation into the RADC formulated concept, to be performed, by independent digital graphics experts under contract to RADC.

Joseph J. Palermo

JOSEPH J. PALERMO
Project Engineer

SECTION I

INTRODUCTION

1.1 Background

Defense Mapping Agency production centers' expend 50%-75% of their resources in chart revision associated activities. Much of the revision is extensive and approaches original chart compilation. Many charts being revised do require original feature compilation; which is merged with other existing cartographic features to result in a new chart issue or a product with major changes in its characteristics. Due to the high percentage of effort expended by the Defense Mapping Agency in maintaining some 97,000 different maps and charts, justification exists for pursuing more efficient chart revision techniques. The pursuance of this project's goals necessarily evolved into several phases of effort. Primary phases were: Problem definition and project effort direction, analysis of existing hardware and software availability and compatibility; methods procedural analysis and initial systems design; experimental testing and evaluation; and revision methods program documentation.

1.2 Purpose

The overall purpose of this project was to develop automated revision methods and integration plans based on an objective technical assessment of various portions of technology characterized by the ACS for application to chart revision at the DMA production centers.

1.3 Report Organization

This Final Report is organized into six sections:

TITLE	SECTION NO.
Introduction	1
Methods Analysis	2
Methods Design	3
Software Development	4
Testing and Evaluation	5
Conclusions and Recommendations	6

Section 1, "Introduction" sets forth the project background and purpose.

Section 2, "Methods Analysis" presents the rationale for revision technique technical requirements, software considerations and hardware evaluation.

Section 3, "Method Design" establishes the criteria by which revision techniques for this project were formulated.

Section 4, "Software Development" details the program and routines produced during the course of the effort.

Section 5, "Testing and Evaluation" outlines the candidate revision methods testing procedures, test results, problem areas and modifications.

Section 6, "Conclusions and Recommendations" relates the findings of the overall project effort including the feasibility of automated revision techniques methods utility; makes recommendations for integration of devised methods and suggests further development efforts.

1.4 References

In support of this project, the following documents were used as references for source information during the implementation of various aspects of the project:

- RADC TR-76-47, Graphic Line Finishing Experiments , (A022090).
- RADC TR-72-143, Experimental Cartographic Software Improvement , (746301).
- RADC TR-74-248, Raster-Lineal Editing Software , (A000937).
- Computer Aided Color Scanning (CACS) Project
- Lineal Input System (LIS) Users Manual Vol I, II & III
- RADC TR-74-245, ACS Batch Processing System Vol I , (A005306).

SECTION II

METHODS ANALYSIS

2.1 Problem Definition and Scope

Investigation into digital revision techniques as part of an automated cartographic system encompassed the defining of specific revision requirements, the applicability of all current software and hardware items available within the RADC ECF facility, requirements for new items, compatibility of convergent hardware/software systems and suitability of application at production centers. It has been established that revision techniques can be accomplished in several ways and technical orientation. Methodology such as; Raster Scanning/Processing; Lineal Digitizing/Processing and combinations of Raster/Lineal processes were considered. These systems/processes were evaluated in light of existing and available hardware and software.

Typical revision call types were solicited from RADC resident DMA personnel and subsequently furnished as an overlay to the Sears Pond Quadrangle chart. Samples of calls as furnished are illustrated in Figure No. 2-1.

The revision calls were used as a base to define specific revision functional requirements, and were separated initially into three categories.

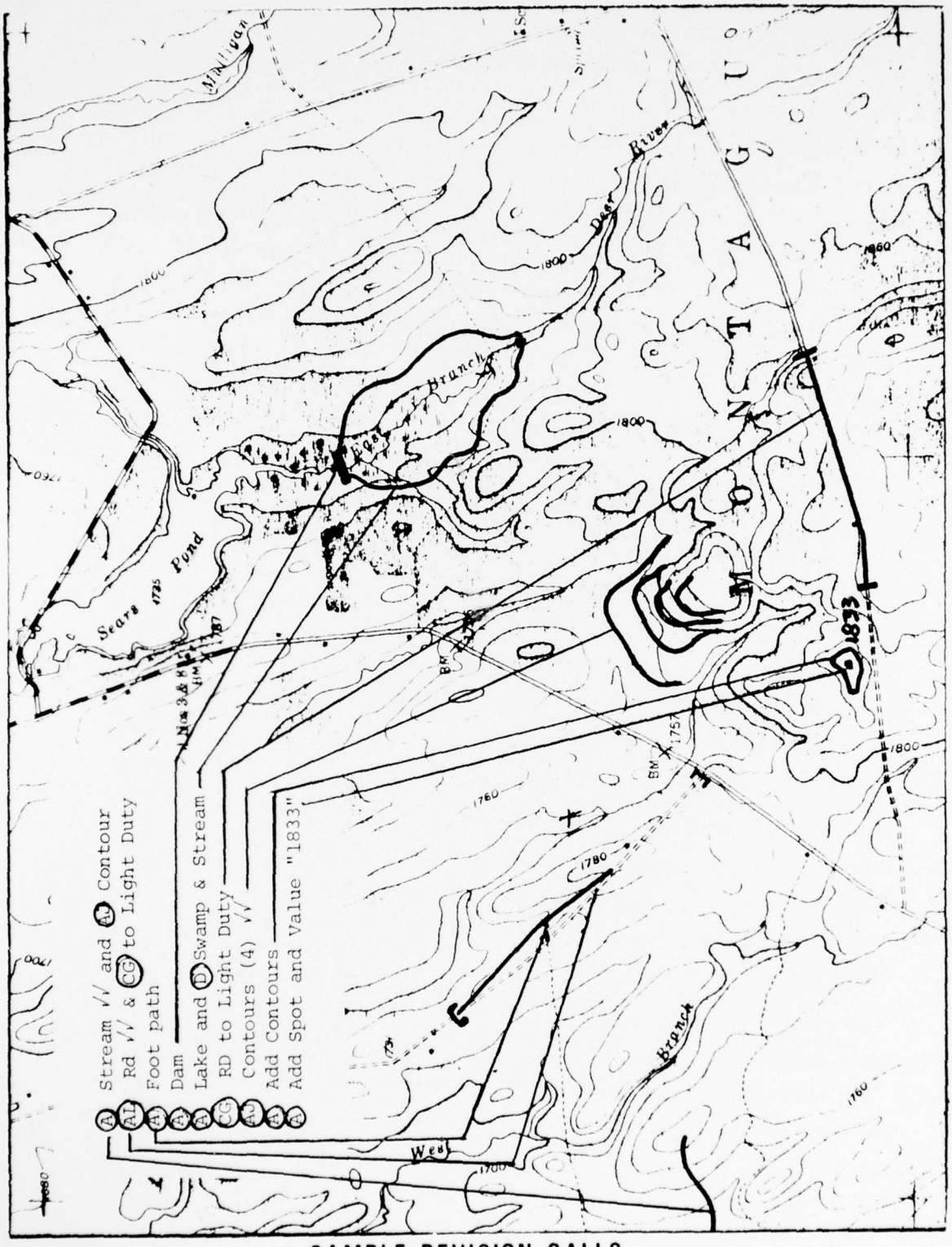
(1) Those requiring header changes only.

(2) Those requiring feature changes.

(3) Those requiring feature and header changes.

Revisions requiring header changes only are typified by call example (CG) Rd to Light Duty, Figure No. 2-1. Revision procedure requires existing feature identification, establishing feature header change limitations and inserting new header data to replace existing data.

Revisions requiring change of physical features without change of headers are typified by call example (AJ) contours (4)√√, and (A) footpath, Figure No. 2-1. Revision procedure requires feature identification (insertion of header data in case of new feature) delimiting feature change, eliminating old data and inserting new data as appropriate.



SAMPLE REVISION CALLS

Figure No. 2-1

Revisions requiring feature header changes are typified by revision call (AL) Road√√ and (CG) to Light Duty, Figure No. 2-1. Procedures require feature identification, delimiting feature change, eliminating old data inserting new data, establishing feature header change limitations and inserting new header data to replace existing data.

Revision actions were further clarified by function type:

- o Header change
- o Feature add
- o Feature delete
- o Segment add
- o Segment Delete
- o Segment Extraction
- o Feature Position
- o Feature symbolization

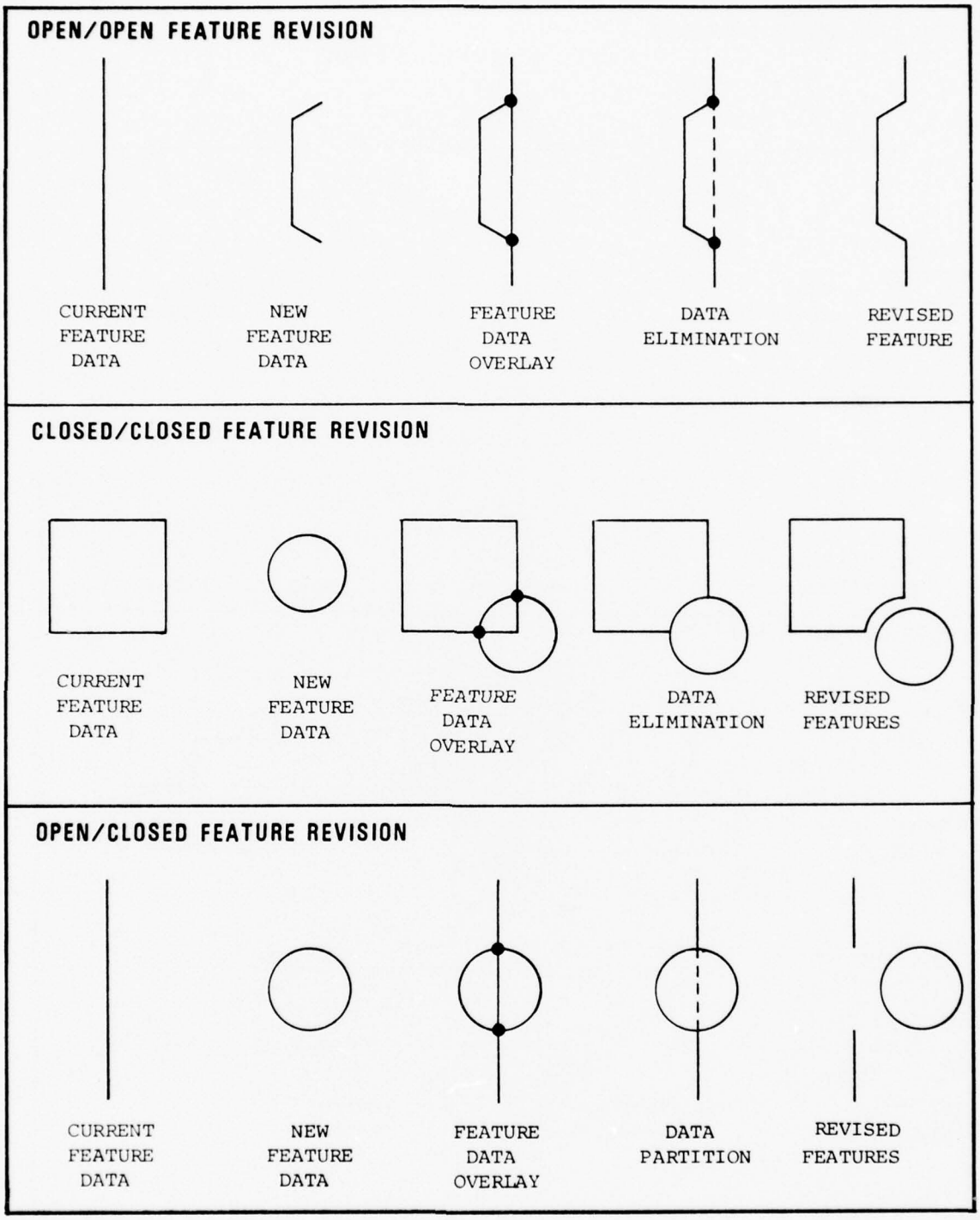
A functional correlation matrix was developed (Figure No. 2-2) to compare basic cartographic revision call functions with required software functions. Incident rate values, gleaned from previous experience data, were assigned to the revision call function to provide priority weighting of required actions. Further divisions include "open" and "closed" feature description and "general" or "specific" revision method application. Part of the theory for automated revision methods relies on the interaction of intersecting data, where the integration of new data into existing data results in subsequent manipulation to achieve the desired result. This can be established in a general mode or addressed to specific circumstances. Figure No. 2-3 illustrates basic "general" feature revision interaction and Figure Nos. 2-4 and 2-4a illustrate basic "specific" feature revision interaction.

The categorization and functional type separation data was used to pin point key revision method areas and establish criteria for systems design and program development.

REVISION CALL FUNCTION	SOFTWARE FUNCTIONS: ADD FEATURE	DELETE FEATURE	ADD SEGMENT	DELETE SEGMENT	CHANGE HEADER	MOVE FEATURE	PARTITION FEATURE	JOIN FEATURES	ADD SYMBOL	DELETE SYMBOL	DESIGNATE SYMBOL TYPE	DESIGNATE FEATURE CLASSIFICATION		INCIDENT RATE	PERCENTAGE
ADD DATA	●		●		●			●	●		●	●		130	20
DELETE DATA		●		●	●		●	●		●				150	23
ALIGN DATA	●	●	●	●	●	●			●	●	●	●		80	12
MOVE DATA					●	●								170	26
CHANGE DATA	●	●	●	●	●			●	●	●	●	●		70	10
CONNECT DATA	●				●			●						50	8

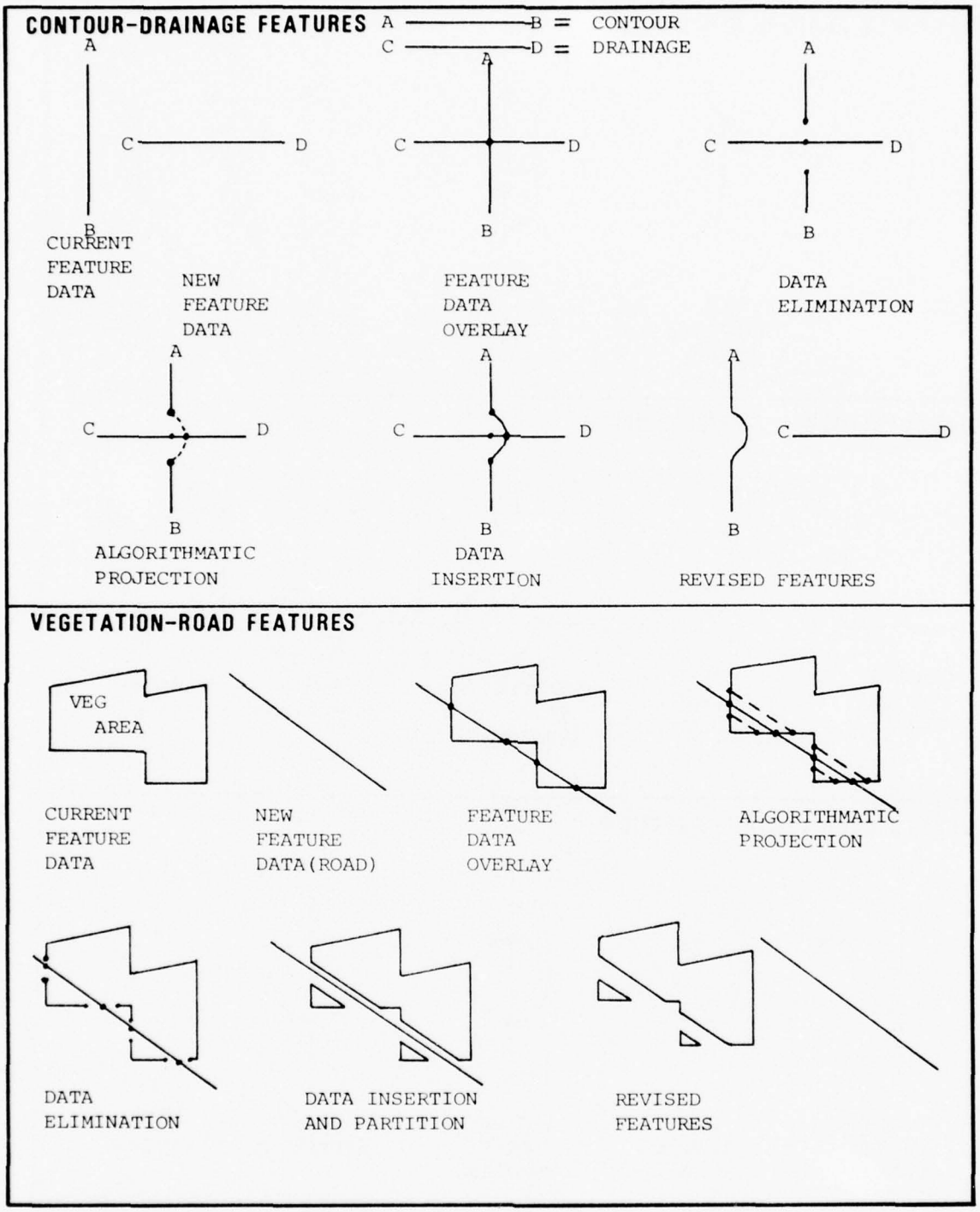
REVISION CALL/SOFTWARE FUNCTION CORRELATION

Figure No. 2-2



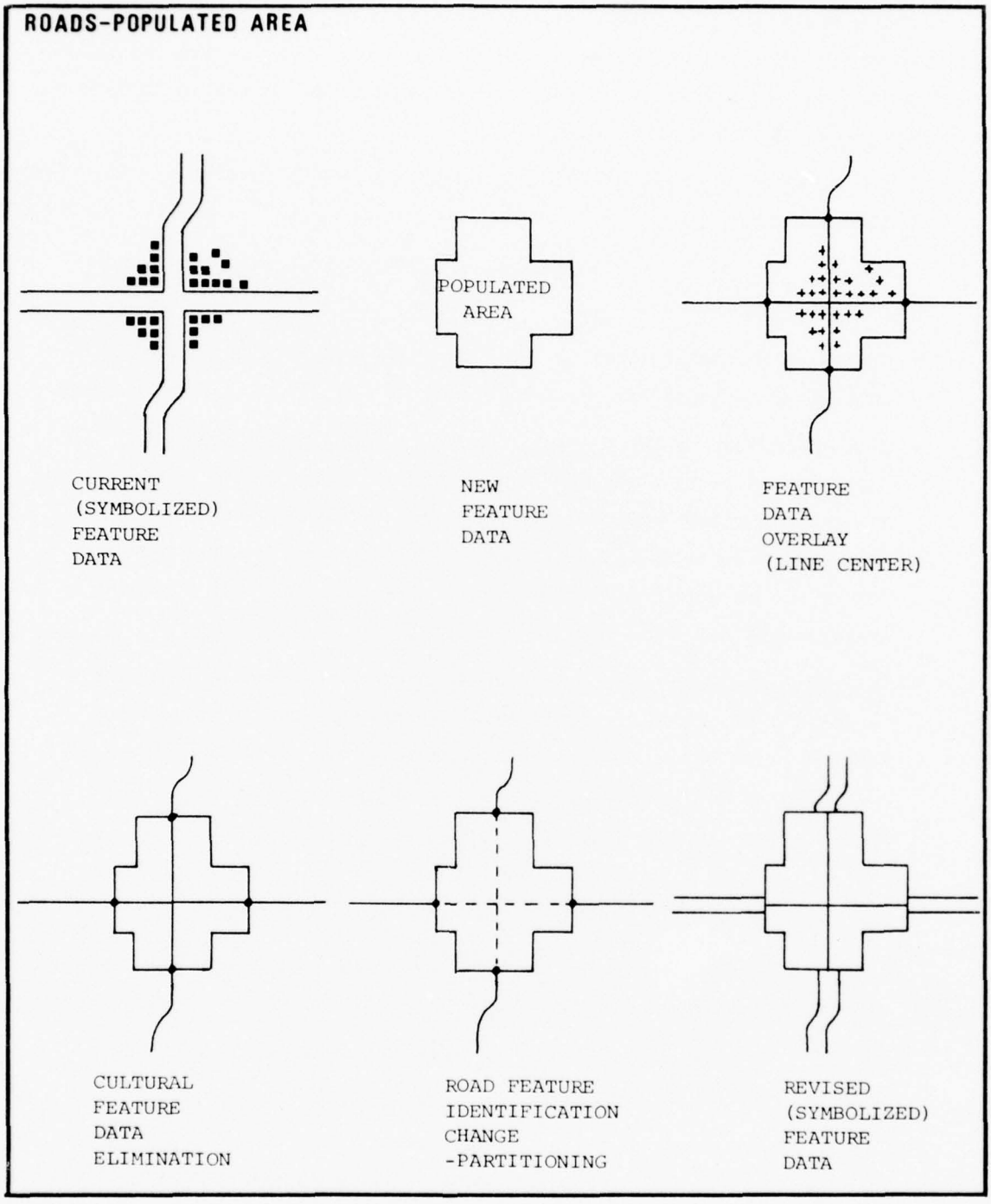
GENERAL FEATURE REVISION INTERACTION

Figure No. 2-3



SPECIFIC FEATURE REVISION INTERACTION

Figure No. 2-4



SPECIFIC FEATURE REVISION INTERACTION

Figure No. 2-4a

During the course of this project, RADC Monitors were consulted on several facets of the Statement of Work content for clarification and guidance. Ground rules for the pursuance of the project objectives, obtained through these consultory meetings include:

- The assessment phase of chart revision was not a part of this effort.
- Source Input would be assumed to be either old analog/new analog or old digital/new analog.
- Future requirements such as Projection Transformation Programming are to be included as recommendations in the Final Technical Report.
- The writing of an MMS to LIS Conversion Program originally ascertained to be a task of Synectics, in order to use previously compiled data files, was deemed unnecessary. The time and overall effort to produce such a conversion program would not be worth the effort since there was no other specific requirement for this type program.
- Revision Techniques Project Data Base to be derived by digitizing a portion of the Sears Pond 7 1/2" Quadrangle Chart, with the entire chart being registered to the table to establish Geo. coordinates for future paneling procedures.
- Area replacement as a revision method is an in-being capability of the LIS system. The use of this method of revision would be a cartographers decision.
- Data files for revision techniques would be in line center format and DMAAC would prefer that format.
- A Revision System per se, is not a requirement of this effort. Emphasis is to be techniques.
- Areas of exploration and procedures as pointed out in paragraph 2, SOW "Scope", and task requirements of paragraph 4.1.7 and 4.1.8. SOW need not be considered.

- o Too much emphasis should not be placed on the Raster Scanning Process and use of the ACSD. The ACSD is not a production system, but could be used in a test situation.
- o Rather than devote a large amount of time to Raster Scanning and conversion exercising, it should be assumed this capability exists and is of production quality.
- o Aspects of revision process to be considered are:
  - Major or minor revision classification (determined by criticality or amount of work involved.
  - Non-critical minor revisions are usually placed in a CHUM (Chart Update Manual) for use at future times when pertinent chart is being revised.
  - Minor revisions can also be defined as those affecting only one plate. Major revisions as those affecting several plates.
  - Example of "major" type revision would be the building of a dam or reservoir. This would involve:

    ✓ Hydrographic Feature
    - Line Representation
    - Color tint
    - Color holdout

    ✓ Contours
    - Realignment
    - Relief tint
    - Color holdout

    ✓ Roads
    - Single line
      - Realignment
    - Cased
      - Realignment
      - Color tint
      - Color hold out

    ✓ Cultural

Dam addition

Town addition

Color tint

Color hold out

- o Hydrographic features take precedence over other features in revision protocol.
- o Area feature blanket deletion and contour adjustment for drainage were not of highest priority.
- o Contour adjustment for drainage features need only to be of very slight indication of flow direction.

2.2 Hardware Evaluation

Hardware systems as propounded by the Statement of Work for the Digital Revision Techniques Project, namely:

- o Automatic Color Separation Device
- o Raster Finishing Plotter/Scan Option
- o Lineal Input System
- o Calma Graphic System
- o Interactive Editing Plotter
- o Experimental Compilation Console

were considered in compiling candidate revision method systems work flow concepts. In addition, the following hardware systems, implied by the SOW[1] were considered:

- o CBS Graphic Plotter
- o Improved Cartographic Conversion Station
- o Calcomp Drum Plotter Model 936
- o Honeywell 635 CPU
- o DEC PDP-9 Processor

---

1. Par 4.1.4 SOW Contract No. F30602-76-C-0104

Figure No. 2-5 and 5a illustrates the combination variables associated with the evaluation of candidate methods work flow systems. It was readily apparent that thorough checkout of all possible combinations was not within the concept of this project. Further, initial evaluation of hardware systems ruled out the testing or further evaluation of the following RADC ECF resident equipment for the following reasons:

- o Interactive Editing Plotter - (Cartographic Digitizer Plotter) This equipment system has been extensively tested and evaluated during previous efforts.[2] The chief attribute of this system is in the editing capability. Lack of sufficient plotting speed and difficulty in producing accurate digitized data prevented its serious consideration as a candidate system. Consideration may later be given as a back-up or supplemental system. It is a supportive system of the ECC however, and in that role is used only for joining and editing features.

- o CBS Graphics/Plotter - This system required extensive repairs and was essentially unavailable as a test system.

- o Improved Cartographic Conversion Station - This system was undergoing final stages of software development and scheduled for shipment from the RADC ECF facility. Although considered a good prospect for fast, accurate input digitizing of revision material, circumstances ruled out its evaluation for revision techniques.

- o Calcomp Drum Plotter Model 936 - This plotter was included for consideration due to its high speed plotting characteristics and interfacing capability with the Bendix Data Grid digitizing systems. The 936 Plotter resident at the RADC ECF was however, a component of the Cooperative Cartographic System, under development for the Italian Air Force and was shipped to the end user in October 1976.

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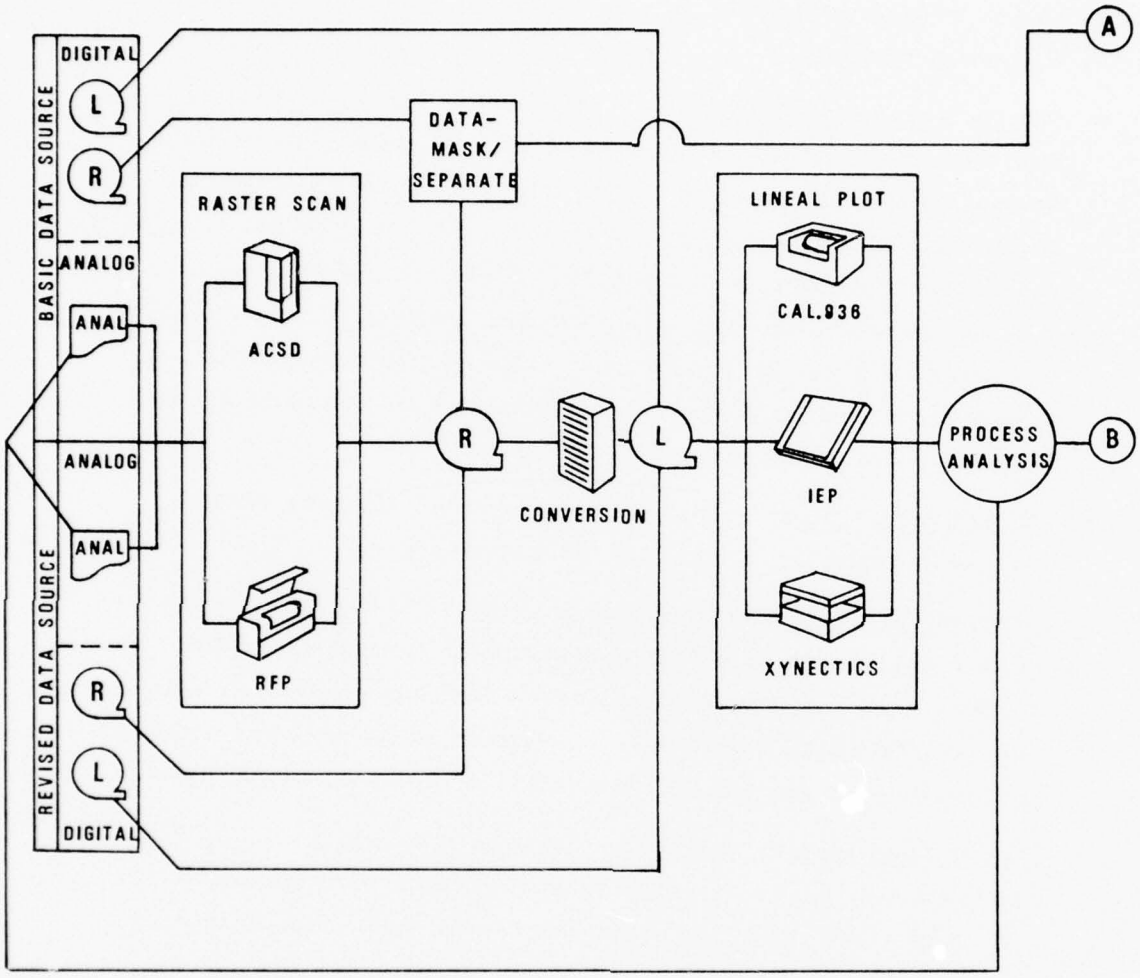
2. Graphic Line Finishing Experiments, Contract No. F30602-74-C-0261



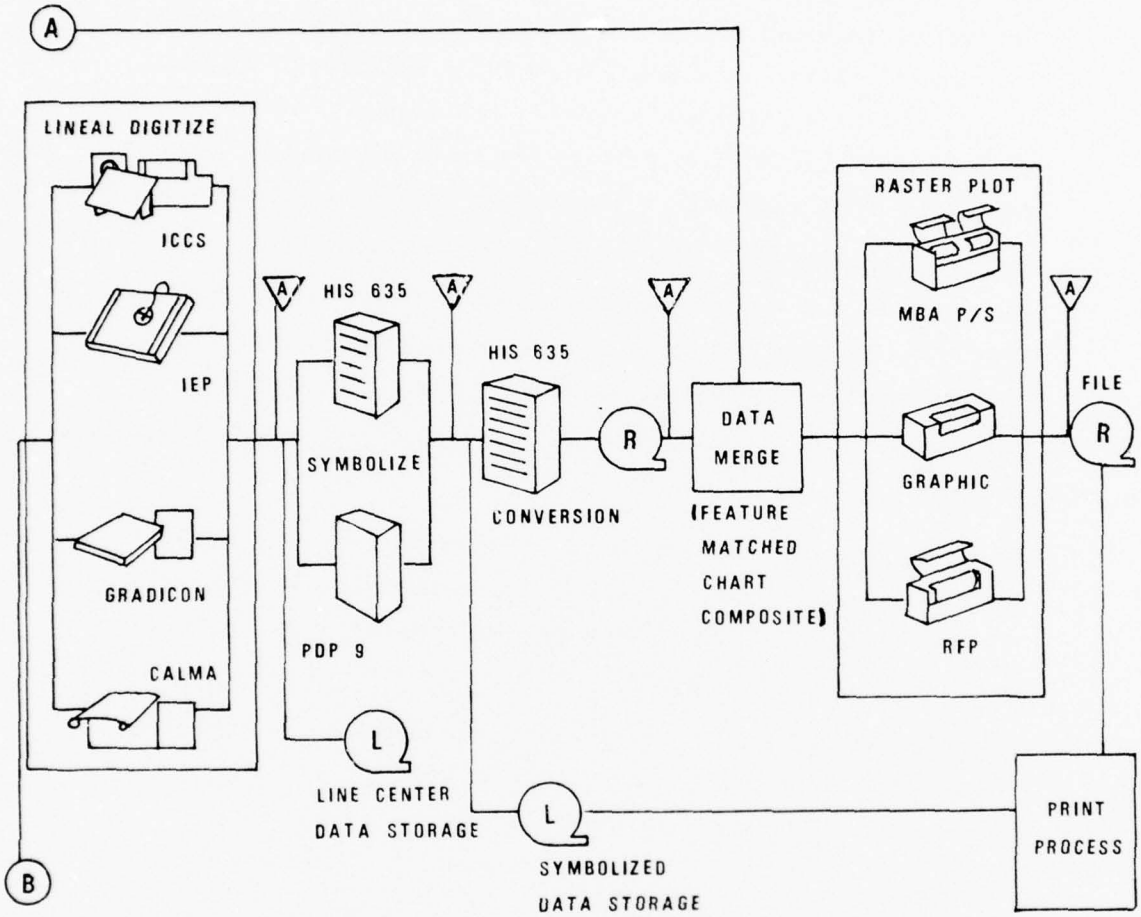
R = RASTER FORMATTED DATA

L = LINEAL FORMATTED DATA

A = EDIT ANALYSIS POINTS

CANDIDATE HARDWARE SYSTEMS/COMBINATIONS FOR DIGITAL REVISION TECHNIQUES PROCESSING

Figure No. 2-5



CANDIDATE HARDWARE SYSTEMS/COMBINATIONS FOR DIGITAL REVISION TECHNIQUES PROCESSING (CONT'D)

Figure No. 2-5A

Some items of equipment and/or cartographic systems components were considered to be of questionable effectiveness and suitability to the Digital Revision Techniques Project. These are:

- o Raster Finishing Plotter/with Scan Option - This equipment was newly delivered to the RADC ECF and operational techniques and system reliability had not been fully explored or tested. Only a plot capability was available and "out-of-facility" repairs were scheduled to provide the Scan capability. System was essentially unavailable for test of digital revision techniques.
- o Calma Graphic System - This digitizing system has not been exercised as far as is known since its re-installation at RADC ECF. Operational technique and system reliability testing had not been conducted independently of this project.

The following equipment/Systems were considered most likely candidates for Digital Revision Techniques:

- o Automatic Color Separation Device - This drum scanner device producing raster formatted digital data has been, with some few exceptions, a highly reliable item. Operational techniques have been fully exploited.
- o Lineal Input System - This system as discussed here, includes the Gradicon/PDP-15 digitizing/editing system, the Experimental Compilation Console and the Xynetics Plotter. The LIS, by current state-of-the-art considerations, offers complete, effective and high speed processing of cartographic data. The ECC (including the CDP/PDP-9 support system) is considered as a part of this system for this project's consideration in so far as the PDP-15 is the main processor for both the LIS and ECC. Certain draw-backs were present in the utilization of this system however. The LIS was undergoind further software improvements under a separate project which limited hands-on use for this project. Operational techniques could possibly not remain static

which could pose problems for methodology evolution. To use MMS formatted data files with its LIS system would require an MMS-to LIS conversion program to be written. LIS is installed equipment at DMA centers.

- o Honeywell 635 CPU - This was a candidate processor for Raster to Lineal and Lineal to Raster Conversion programs and Symbology Programs. No problem exists in its utilization as part of test procedures at RADC, however, this is not a hardware system available to DMA Centers.

- o PDP-9 Processor - This is a required item for utilization of the ECC in conjunction with the PDP-15. No problems are known to exist in utilizing this equipment. During usage as part of the DRT evaluation it would effectively cut off usage of the CDP for other functions or programs. This unit can also be used for Symbology programs.

In view of the various factors involved concerning the above listed hardware equipment, and in light of data conversion problems, de-emphasis of raster scanning/plotting as part of this project's effort, individual system availability and reliability, it was decided to limit revision method design, testing and development to the Lineal Input System (LIS).

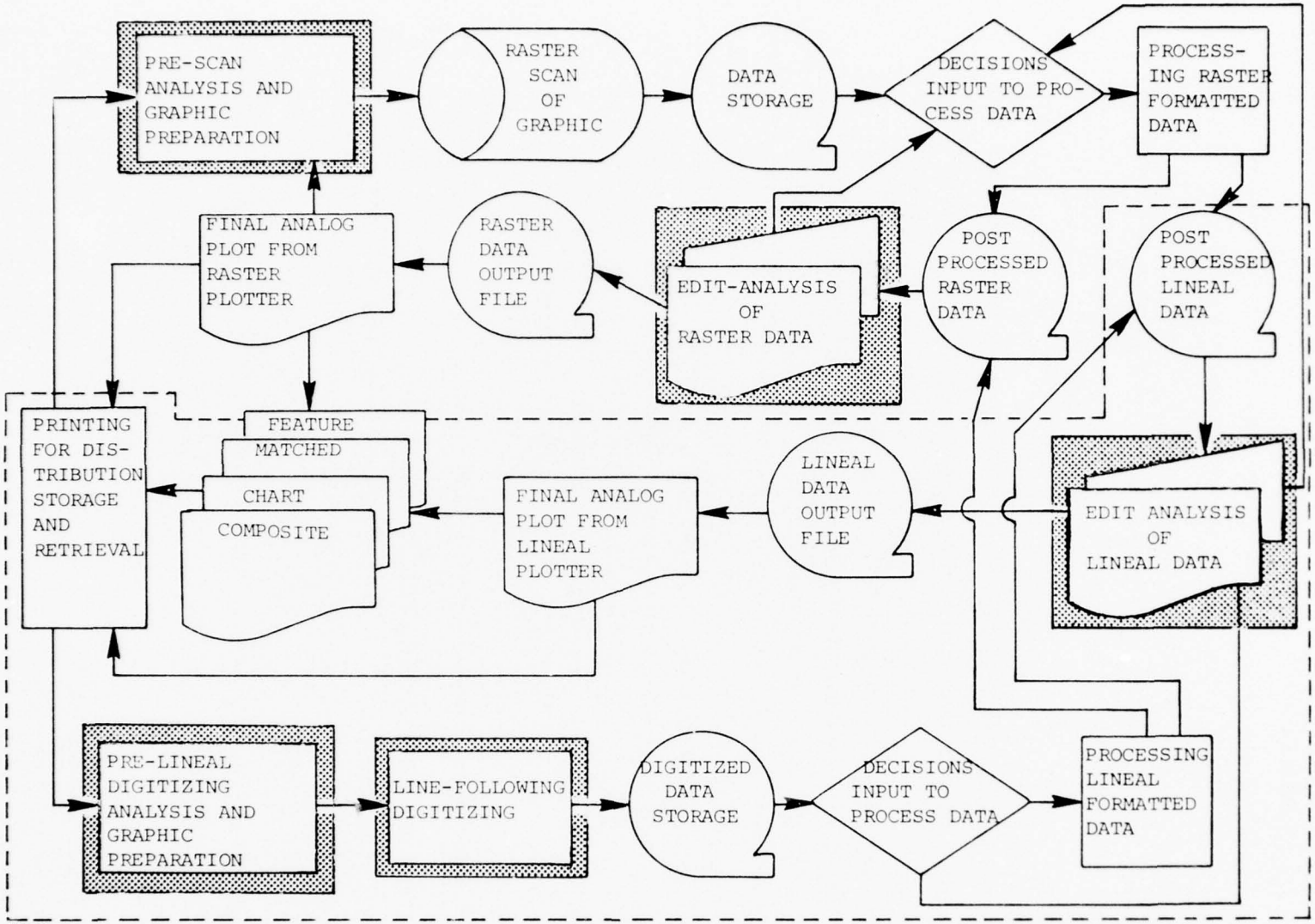
2.3 Software Considerations

Initial revision techniques project software study efforts were devoted to evaluation of all pertinent advanced cartographic system developments at RADC for use in this effort and for future revision techniques engineering efforts. These developments have addressed input, processing and output phases of handling digital cartographic data from both raster and lineal formatted approaches. Both approaches are viable methods for chart revision techniques due to the variety of inputs and where output characteristics are so diverse. The integration of both approaches into an overall revision method technique was evaluated. The data flow of the major steps in using integrated raster

and lineal digital revision techniques for production chart revision is illustrated in Figure No. 2-6. Individual technologies for stations of the data flow are for the most part, in-being, but not to the level of efficiency for production use in a digital revision environment. Certain data processing techniques and cartographic functions which were considered as possible prospective programs to assist in or to be integrated with the revision process software, were evaluated. These were:

- o Lineal to raster format conversion
- o Raster to lineal format conversion
- o Computer Assisted Scanning
- o Feature Identification Software
- o Computer Assisted Color Scanning
- o ECC/CDP Point Symbol and Alphanumerics Placement
- o Data Priority Marking
- o RADC Raster Conversion Program
- o Lineal Symbolization
- o Feature extraction
- o Scaling
- o Smoothing
- o Clipping/Joining
- o Raster Resolution Change
- o Sectioning
- o Transformation
- o Solid area fill-in
- o Merging
- o Sorting
- o Direct geographic-In
- o File Save

The discussion of and comment on the software programs included herein is intended to appraise the reader of part of the many programs associated with cartographic data manipulation. Although many of these programs were ultimately not contained in the specific revision methods as devised by this project, they bear inclusion at this point for consideration in future revision methods engineering.



DATA FLOW ALTERNATIVES IN DIGITAL REVISION TECHNIQUES ASSESSMENT

Figure No. 2-6

Lineal to Raster Conversion

The linear to raster conversion program converts digital cartographic data from a continuous lineal format to a raster scan-line format. The two formats differ in that the lineal format is feature-oriented and is called by feature. All points for a specified feature are physically located together in the data file. The scan-line format is scan-line oriented and is called on the basis of raster scan-lines. All points for a given scan-line are physically located together in the data file. Output of the conversion program is in raster format containing necessary control information such as line weight, density, etc. and can be directly input to the Graphics Plotter. Lineal formatted MMS data files and raster formatted data files generated by the ACSD can be input. Exclusion of specified types of feature data can be accomplished by identifying selection criteria in the input control deck. Header codes are used for selection criteria for lineal data, and for raster data color codes are included which are associated with ACSD raster data input. The primary unsatisfactory aspects of the current basic functions for changing lineal cartographic features to raster form, and that (1) the processing requires too much time and reduces the cost-effectiveness of a high speed raster plotter, and (2) the processing currently results in incorrect overlay (lack of masking) at feature intersections. Also, the physical records on the output tape destined for the Graphic Plotter are fixed length (4096 characters) even though some of the records are only partially full. This necessitates a large quantity of magnetic tape.

Raster to Lineal Format Conversion

The raster to Lineal conversion program is designed to convert raster formatted data obtained through raster scanning of chart products by such devices as the ACSD.

Procedures for converting raster-scanned data to lineal-string feature data to support feature mergence can be categorized into four main processing states.

- o Pre-processing
- o Main processing
- o Editing (On-line)
- o Post-processing

Pre-processing procedures involve transforming the ACSD-generated scan data to a form acceptable to the configuration of the processing system. For example, if raster conversion were to take place on the HIS 635 computer, the input would be reformatted from the 24-bit ACSD to the 36-bit word size.

Processing procedures consist of programs which take the scan-formatted raster records and convert them to lineal data by linking raster points to form X,Y coordinates. The linking criteria are adjacency and color code. If a point of the raster scan line falls within specified resolution limits of another point, and their color codes match, they are considered to lie in the same feature, and the Y-intercepts of the first and second X-intercepts are paired respectively to yield a segment (Y1, X1)-(Y2-X2). The same principles hold for area start, area stop data on a scan line. The coordinate data is then stored in a new feature segment file, or added to a previous feature segment file.

The editing functions typically included in the raster to linear conversion process are initiated whenever line-tracking algorithms in the processing state cannot resolve ambiguities in the linealization of the raster scan data. The editing mechanisms employ established feature-type (e.g. contours: closed features) and line segment-type (e.g. maximum) criteria in correction. If the automatic editing cannot successfully aid in the feature linealization, the feature segments in question are flagged and listed in the statistical hardcopy summary at the end of conversion. Manual editing is performed on the CDP/ECC system to resolve the flagged areas.

Post-processing of the converted data consists of statistical analysis and performance of any residual editing. This is accomplished by using the summary statistically produced and the output MMS tape (with error flags) as input to the CDP/ECC station. Once the necessary corrections diagnosed in the processing/edit stages are made, the final MMS tape can be used for a validation plot, against the source manuscript or overlays to check whether any feature data was not recorded by the ACSD. The final edited tape can then be used as an input to a cartographic data base.

Computer-Assisted Scanning Techniques (CAST)

The CAST system was the initial software effort in attempting Raster to Lineal conversion. The system utilized the RADC PDP-9 computer system. The CAST software consists primarily of the following modules:

- o Color Separation Package
- o Line Connection Package
- o MMS Tape format Conversion Package
- o Statistics Package

Feature Identification Software System (FISS)

FISS was the successor to CAST and utilizes the same hardware configuration. It consists of a set of software programs which accept ACSD-generated raster data, extracted and correlated color tagged positional data based on a hierarchial color scheme, and connects these data elements on point-to-point basis to form lineal data tagged by feature type and converts this data to MMS format.

Computer-Assisted Color Scanning (CACS)

The CACS software implementation is performed on the RADC HIS 635 computer system. The program utilizes both COBOL and FORTRAN higher-level languages. The system was designed as two tasks: the first as a preprocessor which massages ACSD generated data for input to the second job. The second job consists of two activities; one performs feature extraction and the other links and outputs the segments as linealized features.

ECC/CDP Point Symbol and Alphanumeric Placement Techniques

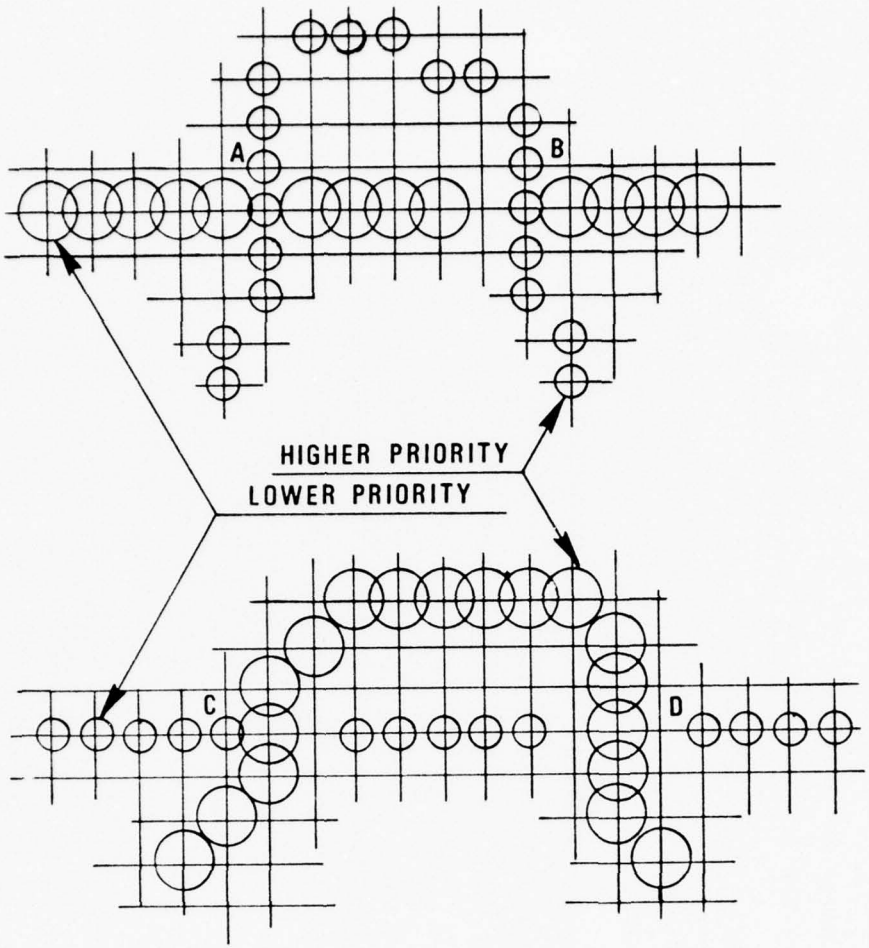
Point symbols to be placed in the map data base are primarily processed on the ECC/CDP. This is accomplished by entering the header record describing the type of symbol to be used (R, F, S, C codes) and a baseline, consisting of two XY-coordinate pairs which will be used to position the symbol with respect to its location and angular orientation on the map. Point symbol data description differs from alphanumeric string format, in that the R,F,S,C codes for the point symbol define a unique symbol, while the R,F,S,C codes for all alphanumeric strings are the same. Conformal elevation numerics contain the elevation

value in the MMS record, while other alphanumeric strings contain blanks in the elevation value words. The existing point symbol library was created virtually "by hand" by laboriously keypunching coordinates of the perimeter data, while the alphanumeric "casing" strings were established by tracing outlines of very large scale characters. The reasons behind the use of two different methods was not established. It appears that the latter approach would be measurably easier to accomplish and certainly the approach which we would recommend for expansion of the library for digital revision techniques applications.

Data Priority Masking Techniques

There is at least some limited capability of performing data priority masking existing in the L-R Image Conversion Programs.

Figure No. 2-7 illustrates four unsatisfactory priority masking conditions which could occur frequently in data prepared for the Graphic Plotter. If the two dot strings shown represent line weights of 5 and 10 mils, both spaced 5 mils on center, the only alternative which we appear to have at an intersection is to produce slight overlaps or slight gaps (2.5 mils) at every intersection regardless of which line has the higher priority. (At intersection "A" only one large dot has been suppressed, at "B" two large dots were masked, at "C" two small dots and at "D" three small dots have been "masked" off to illustrate some of the possible conditions of feature intersections). The amounts of gap/overlap at particular intersection will vary depending upon the widths of the two lines, the center-to-center spacing of the lineal strings, and circumstances of where the dot centers happen to fall, but the problem will always be there to some degree. The error conditions could be minimized by effectively ignoring some of the hardware capabilities of the Graphic Plotter and producing all plots with a single small spot size (1 mil or 2/3 mil) by "painting in" wider lines as areas. To produce plots in this fashion from lineal input data strings would require revisions in the basic concepts currently used in the FCP system.



PRIORITY INTERSECTION MASKING PROBLEMS

Figure No. 2-7

RADC Raster Conversion Program

The Raster Conversion Program under development by RADC currently is run on the CDP/ECC PDP-9/PDP-15 computer system, and programmed primarily in FORTRAN IV, with MACRO being used for I/O processing. Execution takes place in five overlayed segments, which are responsible for re-formatting, linking points, and areas linking of features, and output to MMS tape.

The Raster Conversion Program employs a different approach than that of CAST, FISS, and CACS. Previous tracking algorithms processed the data one scan line at a time. When data linking and tracking is complete for a scan line, processing starts on the next, and a new scan line is read, adding it to the "look ahead" window.

The Raster Conversion Program, after processing a point on a scan line, tracks the remaining points to be found for that feature, using a more "linear" technique, until the feature string ends. Processing then starts on the remaining points in the initial scan line, using the same feature following pattern. When no more unrelated points lie on the scan line, the next scan line is searched for "orphan" points.

Symbolization Function

Automatic symbolization is primarily performed on the HIS 635 with a modified version (no cased road capability) capable of performing on the PDP-9. The symbolization program converts features (i.e. header and data records) to a product specific, symbolized format. Automatic symbology is performed according to product specifications and consists of; modifying a feature data list (line center representation) to conform to a special symbol pattern; placing a two-character code in S9 and S10 positions of the header record which indicate the color separation group; and placing one character code in the S11 position of the header record which identifies the required line width.

Current symbolization consists of the following inputs provided by the user: input manuscript tape; Symbol Control Tape; and control cards (Symbol Usage Specification). Entry and application of symbols by the system is based

on the header/data list concept (e.g. symbol control and usage specifications employ the standard header and data records for data entry). Each MMS feature is identified with a SUS, which in turn correlates the feature type to a set of symbol pieces. The symbol piece records contain the line weight and color separation codes to be applied to the incoming feature. Each symbol piece also contains symbol control data to be applied to a feature data list until the list is exhausted.

Problem areas of the symbolization software are: extensive processing time intricacies of the "improved" dashed line technique, intersections of cased road features with other features, extensive feature segmentation, and the current scheme for specifying symbol usage.

Problems are encountered when a cased road meets another feature. To date, no techniques have been presented which would fully remedy this problem. One consideration is to employ a clipping/joining software routine on cased roads and associated features although this would likely provide only limited improvements.

All symbolization schemes employed segment MMS features. Thus, symbolization processing may receive 100 features and output 100 + n. where n is equal to the number of times symbol pieces are iteratively applied to features. Thus, it is impossible to quantitatively verify that all features input were processed and output (i.e., 100 input and 100 output) without lengthy plotting and visual reviewing.

Feature Extraction

The purpose of the feature extraction function is to physically segment digital feature records onto output files. Extraction can be performed according to cartographic feature type defined by contents of header fields (R, F, S, C, & T). The user specifies the extraction options and criteria to be applied to the input feature records. Types of extraction are header, contour interval, and priority code. Feature records are extracted from input files and include header type, contour interval, priority code, and sectioning.

The extract options are specified on control records by the user. Any one or all of the extract options can be employed by the user. A feature must conform to one of the extraction criteria prior to being "extracted" and written on the primary output (EXTRACT) tape. If a feature does not conform to any of the extract keys within an extract option it is written on the secondary (REJECT) tape. Extraction can currently be performed on feature records contained on multiple input tapes in AIT or MMS formats. The outputs consists of two tapes (Unit 3 - Extracted Features and Unit 4 - Rejected Features) in MMS format and a job summary, consisting of the job type heading, JCRS Card contents. Extract Keys employed, and a note, "EXTRACTION COMPLETED". Extraction processing is based on the following extraction control records input by the user:

o Header Extraction Record (51) - Used to extract features based on contents of the header record. The user can specify required contents of six descriptive fields (R, F, S, C, T1, T2) which are matched against feature header records of the input file. A zero digit can be employed for all characters which are to be ignored in the R, F, S, & C fields. An "A" is used in T1 and T2 for all characters to be ignored.

o Contour Interval Record (27) - used to specify contour features to be extracted which are some multiple of the desired elevation interval.

o Priority Extraction Record (26) - used to specify the lowest priority (0=highest, 7=lowest) to be extracted. The feature priority is identified by the user in header field S8.

o Section Record (16) - used to specify a rectangular area which is used to extract all overlapping features or parts of features. The second area is specified on the Section Record in Text Words 1 thru 4:

T1 - minimum X value
T2 - minimum Y value
T3 - maximum X value
T4 - maximum Y value

The section routine extracts features which contain at least one point on or within the section area. If the extracted feature does not lie completely within the section area, the feature is partitioned such that the extracted feature contains a header and a data list with at least one point in common with the section line.

The current extraction routines set-up "extract keys", from the header data provided on the control record. Extract keys are used for comparison with incoming feature headers. Feature headers are masked by a Logical AND command with the extract keys to eliminate header values which are not to be checked. The feature header is then compared with the extract keys or extract options. If the feature header does not match at least one of the extract criteria, the feature is rejected and written on the reject tape. Minor problems with current extraction processing are associated with user/system communication. Easier specification of extract keys and additional processing summary information (e.g., number features extracted or rejected, etc.) are areas which would improve user/system communications.

Scaling

To have a certain area of map scaled, translated and/or rotated, may be accomplished by simply scaling, translating, and rotating the digital data using a constant scale factor, translation factor, and rotating angle. The scale factor is a number which indicates the desired size of the digital chart area in relation to its original size as digitized. The translation factor is a factor used to move the digital chart in X and Y direction from its original origin. The rotation angle is the angle through which the axis will be rotated (counter-clockwise is positive). The current software for scaling digital data is found within the routine called INPUT and routine IREGSC.

The present capabilities for scaling are: scaling, translation, and rotation. Input parameters for these functions are taken from the input scale card. The scale card includes three data items: a scale factor (i.e. magnification or demagnification factor); a translation value, (X,Y) measured in system coordinates, which is equated to (0,0) for the output feature file, and a rotation

angle, in degrees, by which the X axis would be rotated in a positive direction. The present capability of the scaling function includes the above mentioned items plus an error reporting capability to report magnitude errors in the scanned values.

The present technique used within the INPUT routine is to determine whether scaling is specified and, if so, to calculate the translation and rotation coefficients. These coefficients, along with the scaling factor, are then combined with the registration coefficients to be applied on each X,Y coordinate pair in the feature file. The technique within the IREGSC routine is the same as the above except that a check is made on the magnitude of the new data points and a warning message is printed on the X,Y coordinate becomes too large.

A translation causes all features to move right or left and/or up or down a specified amount. This is accomplished by specifying the present coordinate point that is to become (0,0). For example; a specification of +5, +5 would move all features 5 inches to the left and 5 inches down; a specification of +3, +6 would move all features 3 inches to the left and 6 inches down.

In rotation, the origin will remain fixed but all other points will be rotated by a specified angle.

The magnification factor or scale factor will cause all the features either to expand or to shrink. For example, a scale factor of 0.5 would cause all features to become 1/2 their original size.

A deficiency of the scaling function is that the magnitude of the new data points are not checked for exceeding a specified limit thus introducing data that cannot be plotted because of the magnitude of the X,Y values. Exceeding limits can only occur when scaling upwards, translating, or rotating beyond a certain magnitude for the particular feature file being processed.

Paneling

The paneling function is used to combine two or more manuscripts to form a single manuscript, and is accomplished by smoothly joining together the ends of the features on two or more adjoining charts to produce a single chart. These charts are butt-joined so that the ends of the features from the charts plotted side-by-side do not overlap or leave a gap between their ends.

The current technique of paneling is to first thread on disc or drum, only those features which have continuation codes (C13 and/or C14 of header are set to 4(s)) as their end point characteristics. The continuation codes are entered at time of digitizing to indicate that the feature meets the chart boundary. These threads are simply lists of like headers and as such only features on the same thread may be panelled to each other. The routine that threads features according to the header scheme is called KNITNU. All threads are built before the panelling of features begins. JOB 8 then searches the threads for two features that have end points which are flagged by the C13 and C14 digits in the header and are within 0.06 inches of one another. If no mate is found for a certain feature, the feature is rejected for panelling and placed on the output tape. If mates are found, they are sent to routine PANEL for panelling. The resultant feature is checked for having more continuation ends and other possible mates. It will finally be sent to the output tape when there are no more continuation codes or when no remaining proximate features exist to panel. The resultant feature takes on the second feature header number and the first feature simply disappears from the system. The FORTRAN routine that performs the panelling algorithm is FUNCTION PANEL. The normal paneling situation is for two features to be paneled into one feature. A special case is when one feature is to be paneled to itself, thereby closing that feature. A point is chosen at one half the distance on a straight line between the end points of the two features where they are to be paneled (referred to as panel point). An imaginary circle of influence is constructed around the panel point with a radius of three times the distance between the end point of either feature and the panel point. A distance formula determines when a data point enters the circle. At that time, the data point is moved such that the data point bends toward the panel point. This is continued until the data points fall outside the circle of influence. Data points closer to the center of the circle are moved more than those near the edge so that there is a subtle shaping rather than an abrupt change. The header of the resultant feature is made up of the header of the second feature with the X first, Y first, X last, Y last, taken from the appropriate end points. The bounding rectangle is also formed and placed in the appropriate locations

within the header. For paneling both ends of the same feature, the same operation is performed except that the data list is scanned twice, once in each direction to blend the end points to the panel point. The final header is changed to indicate a closed feature.

Unnecessary maintenance of all features with continuation codes in primary storage is a deficiency of this function. Due to the technique of the paneling function, all features with continuation codes must be stored in core-threaded look-up tables. The thread dictionary (FORTRAN name LOOKUP) is present in core to locate the beginning and end of each thread. Associated with the thread dictionary is a 4095 by 4 word array (16,380 words of memory, FORTRAN name HEADS) which is used to store the thread pointers and other needed data.

Unnecessary maintenance of all features with continuation codes on intermediate storage devices is another deficiency. The threading technique of storing puts a burden on intermediate storage devices because of the large amount of data that needs to be stored. In the present system, over 200 links of storage are needed to run any job. Many times, 200 links are not available for a run and the job has to be processed after working hours, thus increasing turnaround time. The core and processing time that the maintenance routines use and need are an unnecessary burden on the overall system.

As mentioned, all features with continuation codes are stored on disc or drum. Within routine JOB8, much of the thread searching is unnecessary due to the fact that many of features stored on disc or drum will never be paneled in a particular run. An example of this is when two charts are to be joined together. All features with continuation codes are stored on disc or drum. Features with continuation codes that do not meet or come close to the panel line are unnecessarily maintained and stored on disc or drum. The cost of excessive I/O manipulations is thus incurred.

Smoothing

The smoothing function reduces the undesireable effects such as "stair step" effect as a result of digitizing, and produces a more aesthetically pleasing product. The FORTRAN language routines performing the smoothing

are the GENERALIZATION PROGRAM (the main program in Generalization) and FUNCTION SMOOTH. In the smoothing operation, all features composed of n data points are smoothed by a smoothing algorithm. N is a number from 5 to 35 which varies the degree of smoothing to suit the operator's judgement (higher numbers smooth more).

The present technique involves making independent least square fits of quadratic polynomials to a series of points and then moving the interior points. The points examined are then shifted down the list by one and the operation continues until the feature runs out of data or an absolute point is found in the data list. First, last, and absolute points are not moved thus retaining the special characteristics of intersection and join points in the feature. First and last points remain untouched by simply not smoothing these two points although they are used in the calculation of the coefficients of the least square fit. Points that are absolute are not moved, as per the absolute point map found in the upper half of word two of the data record. A bit is set for each absolute X,Y pair that is not to be moved.

The documentation of function SMOOTH states that when 21 points were used in the smoothing algorithm the best results were obtained. Smoothing cannot occur until n points are input to an array (n is a number from 5 to 35 which varies the degree of smoothing to be performed). For each sequential point put into the top of the array, the smoothing algorithm is performed on the array and the last point is output. The one-point-in-one-point-out technique increases processing time. If the degree of smoothing desired is large, that is n is approaching 35, then the processing time is further increased. It also has been noted, through testing, that absolute points or points that should have been considered absolute were smoothed thus altering one or more significant characteristics of the feature. Another deficiency of the present technique of smoothing is that the algorithm used, physically moves X,Y coordinate points of a feature beyond a desired amount. This may possibly alter one or more significant characteristics of the feature.

Clipping/Joining

The clipping/joining functions effect a clipping or joining action on adjacent digital features generated at the digitizing station. Digital clipping or joining is necessitated by inadvertant overruns or underruns, respectively, when the end point of one feature is in common with an intermediate point of another feature. Clipping involves the deletion of points produced as a result of a feature overrun. Joining involves the addition of points to a feature in order to close the digital gap produced by an underrun. In the current systems, clipping is accomplished by interrogation of the clipping codes entered in the feature header records at the digitizing station. These codes indicate for each feature the number of times the feature is clipped by any other feature.

The current technique for effecting feature clips and joins involves disposition of the entire input feature file on random access memory. As each feature is serially input it is written to the random access device. The feature is also retained in primary storage if it contains a header code that indicates that it is used to clip other features. All features which are to clip other features are retained in a "clipping possibility list" and checked against all subsequent features for possible clipping action. Each time a feature in the clipping possibility list is used to clip a subsequent feature, the tally in the S9-S10 digits of the header record is decremented. When the tally is decremented to zero, the feature is removed from the clipping possibility list. This scheme requires that features acting as subjects of a clipping operation be digitized prior to all related features serving as objects of the operation.

The clipping possibility list which is retained in core storage can become unduly large, adding to the already burdensome storage requirements and the necessity to enter the clipping codes for each feature proves to be quite cumbersome for the cartographer at the digitizing station.

To assure absolute joins for all adjacent features, the cartographer at the digitizing station must overtly overrun the end of each feature to be clipped.

Raster Resolution Change

The purpose of the Raster Resolution Change function is to alter the resolution of the digital cartographic data records generated by the Automatic Color Scanning Device (ACSD). Basically, this process involves insertion or deletion of data elements (X,Y pairs) or deletion of data elements (X,Y pairs) for a resolution increase or decrease respectively, in the digital resolution.

In the current system the Raster Resolution Change function is performed by the ACS Format Conversson Programs. The primary objective of the Format Conversion Programs is to prepare data for direct input to the Graphic Plotter. The system accepts and processes either lineal or raster formatted data. When raster format data is supplied as input, the resolution of the data is altered according resolution parameters supplied on user-entered control cards. Therefore, in the current system, the Raster Resolution Change function exists as a capability that is secondary to the process of preparing data for input to the Graphic Plotter.

Among the various control cards supplied to the Format Conversion system are resolution specifications cards: INPUT RES and OUTPUT RES. These cards specify the resolution of the input and output data in terms of the number of data elements (X,Y pairs) per inch.

Legal specifications for input files are: 100, 200, 250, 500 and 1000.

Legal output file resolutions can be specified as: 166, 250, 500, 750, 1000, 1500, and 2000.

These legal specification values for input and output data are geared to current ACS/ECF raster devices, i.e., the ACSD and Graphic Plotter, respectively.

The input and output resolution parameters supplied on the INPUT RES and OUTPUT RES cards are used to compute a scaling factor by dividing the input resolution value into the output resolution value. This scaling factor is then applied to all incoming coordinate data in the ACSD program (the program that input processes all ACSD raster data). Data are thus scaled by the ACSD program and written onto an intermediate file. The executive program then

determines whether the input resolution as specified is less than or equal to the output resolution as specified and, if so invokes the raster interpolation module (INTR). The raster interpolation module interpolates between adjacent points on the intermediate file to achieve the specified output resolution. If the specified input resolution is greater than the specified output resolution, then no interpolation takes place.

The raster resolution change subfunction of the Format Conversion Programs does not contain deficiencies as such but possesses inflexibilities accruable to the fact that the capabilities were developed for application to specific devices. There is no current capability therefore, to effect a Raster Resolution Change in the purest sense.

Sectioning

The purpose of the Section Function is to extract all features or parts thereof, which overlap a specified area. The section area is specified by the user in terms of polygon corner coordinates or end points of a section line. Sectioning is currently initiated by including a section control record in the ACS control deck. Multiple input tapes in AIT or MMS formats can be processed by a section run. The output consists of two tapes (Unit 3 - Extracted Features and Unit 4 - Rejected Features) in MMS format and a job summary, consisting of the job type heading, JCRS Card contents, Extract Keys used, and a note "EXTRACTION COMPLETED".

The section record (ACS Record 16) is used to specify the desired section area. Currently only rectangular areas can be sectioned and thus only the lower left and upper right points are required to specify the section area. The two points are specified in Text Words 1 through 4.

T1 - minimum X-value
T2 - minimum Y-value
T3 - maximum X-value
T4 - maximum Y-value

The section routine extracts features which contain at least one point within the section area. If the extracted feature does not lie completely within the

section area, the feature is partitioned such that the extracted feature contains a header and a data list with at least one point in common with the section line. The portion of the feature that lies outside the section area is output on the reject tape with appropriate header.

The current section software sets up the X and Y boundaries of the section area. The first point of each feature is compared with the section boundary to determine if the feature start point is inside or outside of the section area. Each subsequent data point is compared with the section area until a change is detected with respect to the section boundary. Data point comparison with the section area is very straightforward since the section boundaries are limited to horizontal or vertical lines. Each feature segment extracted or rejected is given a continuation code and a data point which coincides with a section boundary.

Only rectangular areas can be specified for extraction due to the fact that only two points can be provided by the user, and the two points are assumed to be the lower left and upper right corners of a figure, thus defining a rectangle with a horizontal base line.

As noted above, the user specifies the lower left and upper right corners of section area which is to be extracted. Difficulty is encountered when attempting to determine the area which is to be extracted to X,Y values on the tape. This is because little is known about the precise orientation of the digital file with respect to the origin. More information is required to be provided to the user concerning the registration of the digital file in order that the user can validly define the desired section area. The current section software routine will extract only those feature segments containing data points which lie within the section area. Straight line feature segments which overlap the section area but are defined only by end points will not be extracted unless one of the end points is within the section area. Thus, assurance that all features will be extracted which overlap the section area is not currently possible.

Transformation

The purpose of the transformation function is to perform cartographic projection transformations upon digital feature files. Features in table coordinates can be transformed into geographic coordinates and vice versa. There are four different projection systems supported by this function: Lambert Conformal, Mercator, Transverse Mercator, and Polyconic.

The LIS can take input feature data in geographic coordinates, project the data into a plane cartesian coordinate system via the desired projection transformation, and produce feature files in table coordinates. The LIS can also perform the inverse transformation. That is, it will take features, digitized in table coordinates from source materials, and perform the inverse projection on these features into geographic coordinates. In addition, features in one table frame may be transformed into another table frame with a possible change of source chart orientation. Input and output feature data in both table and geographic coordinates may be on magnetic tape. The table data formed from the source document can have a recording resolution as small as 20 microns, while geographic data on output will be accurate to .01 seconds of arc. The user can select the types of transformations he wants and the order of the transformation processing through the use of on-line work stations. For instance, after logging on the system, the user presented (on the display) with a menu giving selection numbers and the LIS tasks associated with them. If a table to geographics transformation were desired, the user enters the appropriate selection number. The LIS registration allows master registration points to be computed from geodetic parameters and is an interactive function providing the cartographer the capability of determining the accuracy of his digitizing process. The LIS transformation function is divided up into two tasks: geographic transformation and table to geographic file conversion, to form a geographic file from a table file. Each of these tasks operates in the deferred batch environment of LIS and is scheduled for execution by the LIS monitor system when a request comes from a work station. Each task executes in a certain memory partition of the PDP-15 main computer and contains a driver program as a front-end to precipitate the execution of the other programs (or sub-programs) of the task. Overlay procedures are used if a task requires more memory than that allocated to a partition.

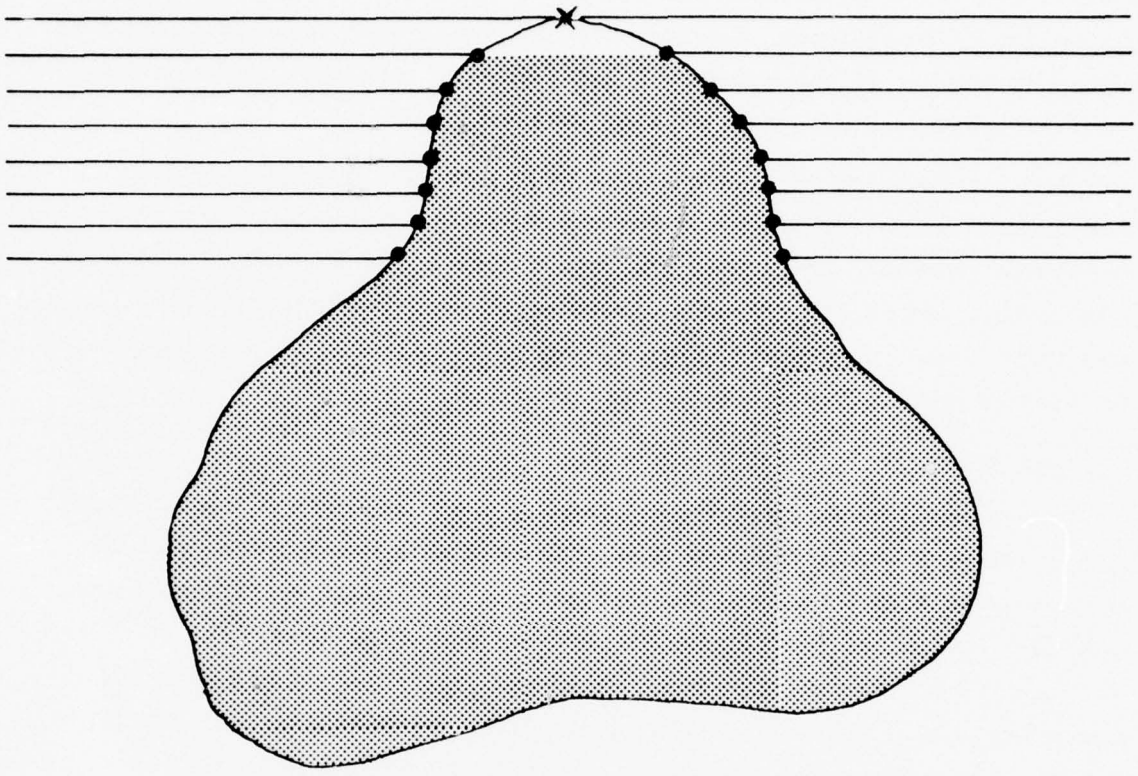
There are various mathematical algorithms employed in performing the transformations. Most of the algorithms are based upon standard techniques found in the literature. The table to table transformation coefficients based upon the deformation parameters calculated during registration.

The LIS registration function is separated into the tasks session start, file deformation and part of the geographic transformation task. The session start and file deformation tasks compute the registration deformation parameters and operate in the interactive batch environment of LIS. They are executed through requests from work stations and are given a higher priority than the deferred batch programs. Least squares best fit criteria area used in the determination of the deformation parameters (transformation coefficients for the affine equations).

Solid Area Fill In (of a single closed feature)

This fill-in is done by specifying the points along the closed features as "area-start/area-stop" pairs. When the raster plotter detects these pairs, a continuous line is plotted between the pairs. When the whole feature has been plotted, these lines then appear to merge together, creating the desired solid effect. This is a fairly straight-forward process for a typical cross section through a closed feature occuring wholly within the chart boundary (such as a lake). However, two possible error conditions can exist. If a closed feature meets a vertical chart border, provisions must be made for the processing to treat the border as part of the feature point string. Either the ECC/CDP programs must be altered to synthesize (interpolate) the necessary data points as the MMS tape is being written, or the FCP routines LFEC or INTL must be revised to accomplish the same result. Another error source may be points of tangency between feature and scan line. Figure No. 2-8 illustrates this. On these intersections there are no start-stop pairs, since tangency occurs at only one point, therefore certain ambiguities may be expected in this situation.

Interior fill-in between two designated closed features is a supplementary format conversion function. This function, along with area fill-in a closed region is necessary for the generation of various tint band and open areas



X = LINE CENTER POINT

● = AREA START/STOP COORDINATE DATA

FEATURE TANGENCY PROBLEM

Figure No. 2-8

masks. As with the conversion function discussed above, there are several sources of ambiguity in the implementation of this function. Since tint band creation is governed by the area start-area stops of features, it is possible that, due to contour tangency from coarse resolution selection, a tint bant can be lost. In addition, discrepencies may exist with respect to separate, adjoining areas. If the boundary between them is not suppressed, a "polarity reversal" point and an erroneous plot will result.

Another function studied involves processing of conformal contour elevation numbers which are placed on the contour lines on the ECC/CDP. The format conversion programs accept this MMS output data and convert the coordinate points which define the string's perimeter from a line-center to area start-area stop format, in order to obtain a solid character fill when the strings are plotted on the Graphics or Scanner plotters.

Merging

The merge program function essentially reads two disk files and writes both files on a selected output disk file area as a single file. The MERGE program is written in MACRO15 and operates on the PDP-15 central processor. This program, is called via RJE/JSM routines and calls subroutine SERCL to retrieve the RJE block. The input and output file names, along with the user identification number, are extracted from the RJE block and the files opened. The program then reads the two input disk files and writes both files on the selected output disk file area as one file. Both input files must be either GEO or VECTOR. If they are vector files, the second requested file will be transformed to the first input file. The scale, resolution, and projection of the two input files will be compared and if they disagree, then the program will abort. The program will operate properly only on a standard LIS formatted data file.

Sorting

This program (SORT) reads an input disk file, filters it (if requested) and writes the accepted features on one disk file and the residual features on a second disk file. If the residual file is not requested,the input file

is just copied on the output file, with the filter and residual file being ignored. The SORT program is written in MACRO15 and operates on the PDP-15 central processor. By utilization of a copy flag within the SORT program, a call to the routine WRTDSK results in a writing of the Ø and 2Ø records to both the accepted and residual feature files. This program will operate properly only on a standard LIS formatted geographic data file.

Direct Geographic-In

This program (DIRGE) provides a capability to filter a data file and direct the residual features to tape, disk or discard at the option of the user. The program is written in MACRO15 language and operates on the PDP-15 central processor.

The DIRGE program is called via RJE/JSM and calls subroutine SERCL to return the RJE block. The RJE block is examined to open the selector disk file(s) and determine if a filter was requested. The main disk file will be opened and, if a filter was not requested, this program will be set up to copy the input tape file to disk. If a filter has been requested, a call will be made to RFILT subroutine to read the filter and a test for a request residual file is made. If a residual file has been requested, this program will either open the residual disk file and set flag to residual on disk, or it will set the flag to residual on tape.

Once the operator parameters are set the tape will be read by a call to GETFG. The zero and twenty records will be copied from tape to the accept disk file and, if a residual file has been requested, to the residual disk or tape file. For a residual disk file, the double write parameter to WRTDSK will be set for the Ø and 2Ø records. This will cause subroutine WRTDSK to write each record on both disk file. For a residual tape file, a call will be made to WRTDMS subroutine to write the Ø and 2Ø records on the residual tape. The input feature header record will be read via GETFG, and filtered via subroutine FILTER, if requested by the user, and written to the preset file. The first feature header record is examined to determine if the file is a vector or geographic file when the residual file is to be written on a magnetic tape. The results of this examination of the first header record will be used to set a flag which will determine if WRTGEO or WRTDMS will be used to write the residual file on tape.

Each trailer record read by GETFG, examines the FILTER subroutine's return status to determine if the feature was accepted or rejected. The appropriate subroutine will then be called to write it on the accept disk file, residual disk file, or tape residual file. If the residual file is on tape, the program will call FETST and TOTST to compile statistical data pertaining to each feature. A normal completion a call is made to STATOT, which writes the 90 record on the residual tape file, rewinds the tape, and print the residual file statistics on the line printer.

This program will operate properly only on a standard LIS formatted data and filter file.

File Save

The File Save program (FILSV) reads a vector or geographic data file from a disk pack, repacks the data in each feature to eliminate unused areas in the data block, and writes the data file on magnetic tape. During the transfer of a file, statistical information is computed and inserted into a record type ninety, which is written on the magnetic tape after the last data block. This statistical information is then formatted into a report, which is listed on the line printer.

In addition, the FILSV program provides the capability of merging two geographic coordinate data files and write the resultant packed file on tape with a ninety record and a statistical report. The first input file must be on disk and the second input file may be a disk or tape. The FILSV program is written in MACRO and operates on the PDP-15 central processor. The FILSV program will properly transfer a data file only if the file meets the LIS file format specifications. Also, this program will only accept geographic file format when the options input file is requested.

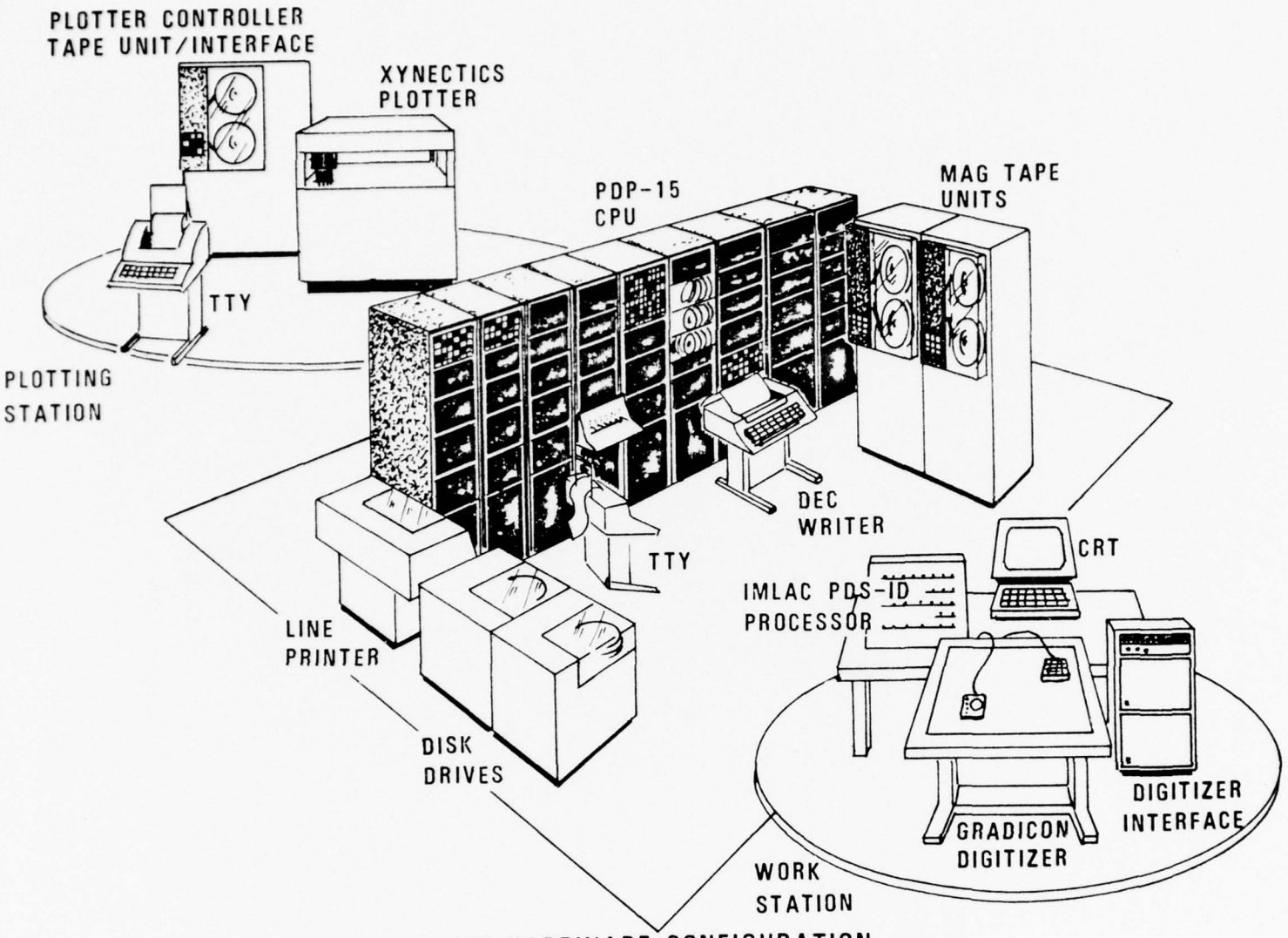
2.4 Method Assessment

The selection of a specific method of effecting automated digital revisions within the scope of this project to a major extent rested upon the capabilities and availability of hardware equipment in place in the RADC ECF facility.

Also, but to a lesser extent, the method selection was attuned to existing software as it applied to the available hardware. Complete new hardware/software systems were ruled out as not within the purview of this effort. Elaborate new or modifying software to effect revision techniques was deemed redundant and effort wasting since many cartographic data manipulation software programs were in-being and/or under development for use in the field.

As elucidated in paragraph 2.2 the hardware selection was narrowed to the Lineal Input System. This hardware system under advanced development at RADC, and in production utilization in the field, possess the basic requirements for implementation of an advanced automated digital revision system. Its primary design purpose is to accurately convert selected cartographic analog source data into digital form for storage in the ACS data bank and to recover, edit, and maintain the currency or improve the accuracy of such digital data as new cartographic source information becomes available. As such, its principal utilization is to build a digital data bank of lineal information from cartographic source materials. However, the system also supports recompilation recommendations and chart update requirements by producing digital data independent of any specific product format or specification, yet is capable of being rapidly transformed and converted in output to fit most cartographic product requirements in terms of feature selection, scale, projection, type or name. The hardware configuration of the LIS as configured at RADC ECF is illustrated in Figure No. 2-9.

The LIS work station consists of a PDS-1D processor, CRT terminal, Gradicon digitizing table and the table electronics interface. The PDS-1D processor provides control for executing station functions, manipulating feature and control data, and creating CRT displays. The CRT provides the mechanism for informing the operator of the systems status and of input requirements. Two keyboards are present at the work station. An alphanumeric keyboard, utilized for data entry and a special function keyboard, for selection of special digitizing and editing functions. Both keyboards are portable. The Gradicon digitizing table is equiped with a five button cursor and the table controller contains power/set-up switches and X-Y coordinate digital displays.



LIS HARDWARE CONFIGURATION

Figure No. 2-9

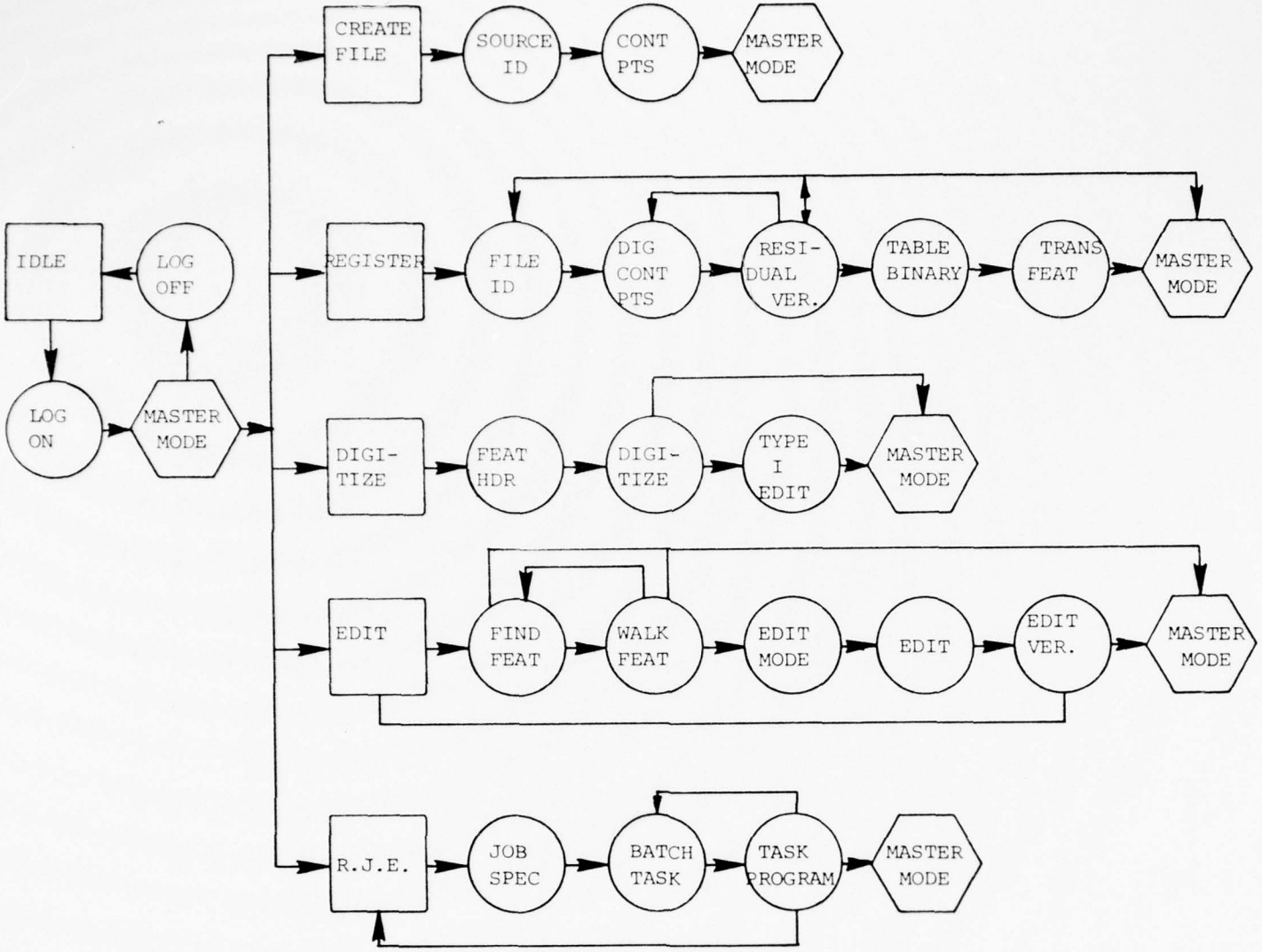
The operation of the LIS Work Station is controlled primarily through a menu selection/manipulation process, with a "master mode" state being the key to all operations. All functions are selected from this state and return to it upon completion. Illustration of the various work station functions is contained in Figure No. 2-10.

Software concepts for digital revision techniques were formulated based on a review and analysis of existing software (as outlined in paragraph 2.3), the requirement for software to be compatible with the hardware system(s) to be employed, guidance from RADC monitors and task consideration. These concepts were formulated with the intention of placing specific hardware and software into their most productive portion of the overall chart revision workflow. This meant consideration of alternative use for specific technological items based on the realities of chart revision such as:

- o Accuracy of revision to be performed.
- o Feature type to be handled.
- o Volume of individual feature type.
- o Input and output format alternatives.
- o *Time constraints affecting each step.*
- o Overall respnsiveness required.
- o Generality of use for each technique.
- o Legacy of the devised methodology to be useful in the future as expanded capability and interfacing components are introduced.

In proposing specific revision methods, it must be noted that within the scope of this project, not all of the cartographic revision methods are necessarily "finished" or "polished". Some further development in hardware, software and integration techniques may be required.

In addressing the revision process in a broad sense and establishing a rationale for revision data to be integrated into a current data file for a composite map/chart product an assessment Procedural Flow Chart was developed (Figure No. 2-11). This flow illustrates, in very basic terms, the various



WORK STATION OPERATIONAL FUNCTIONS

Figure No. 2-10

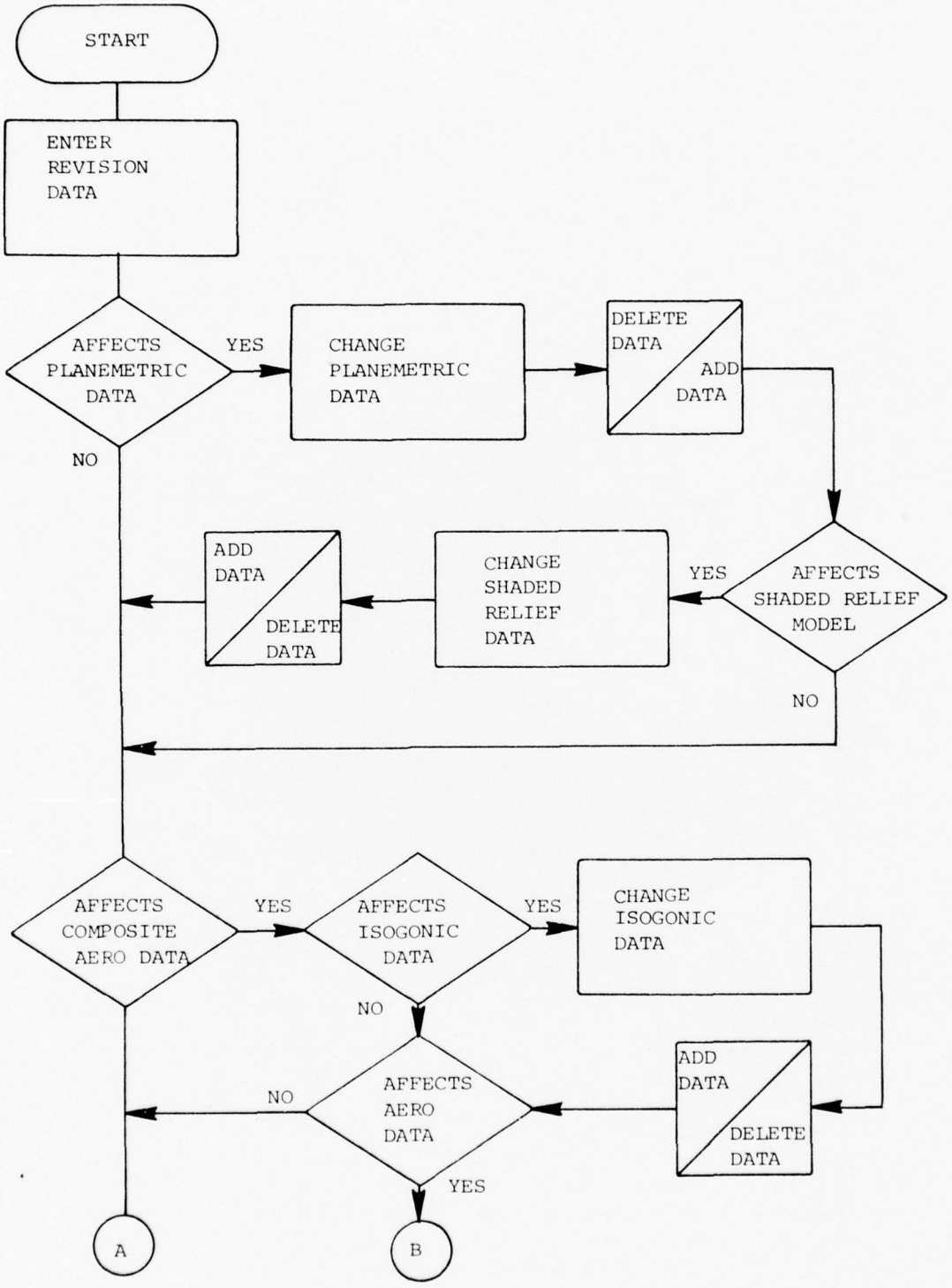
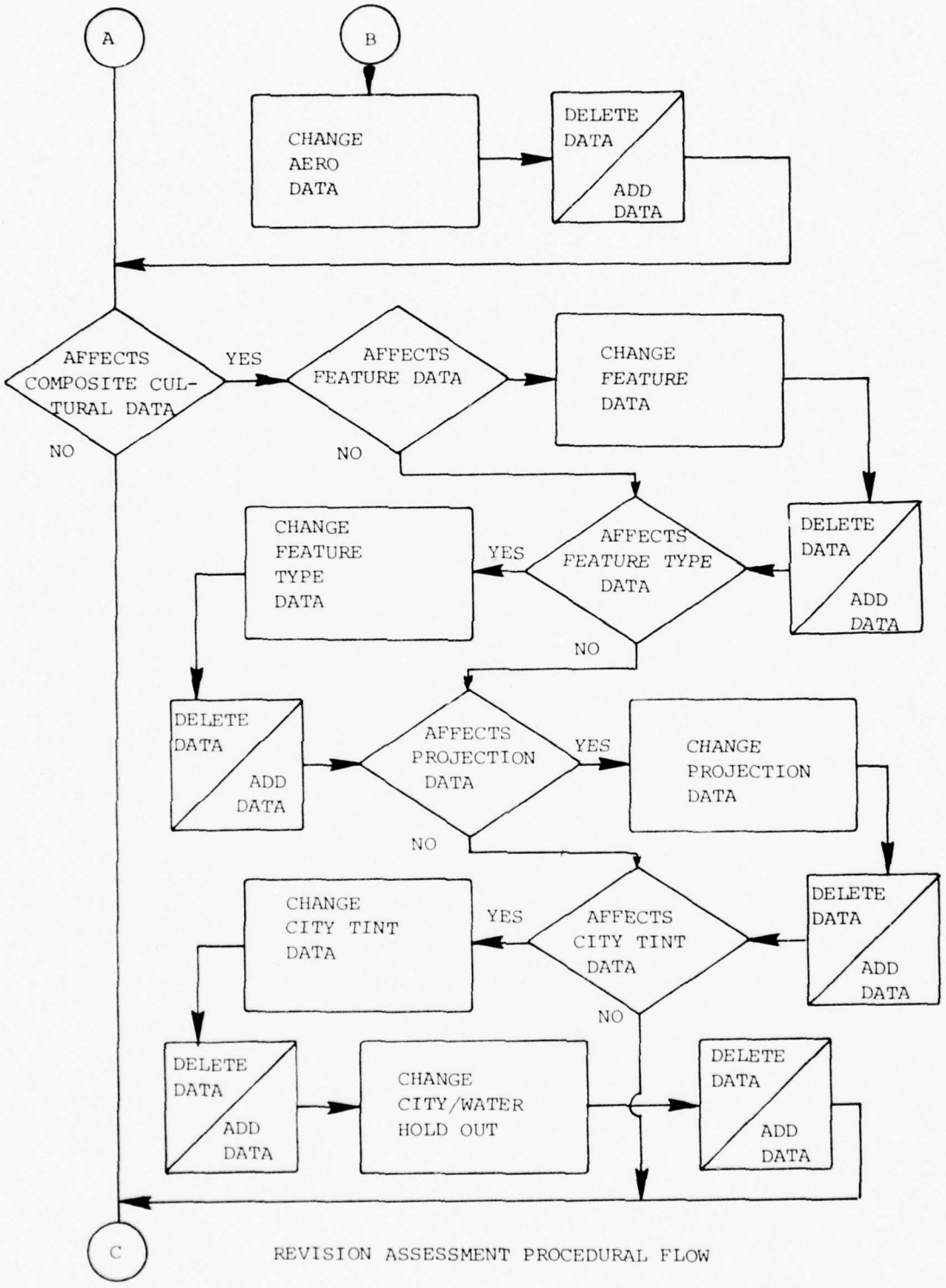
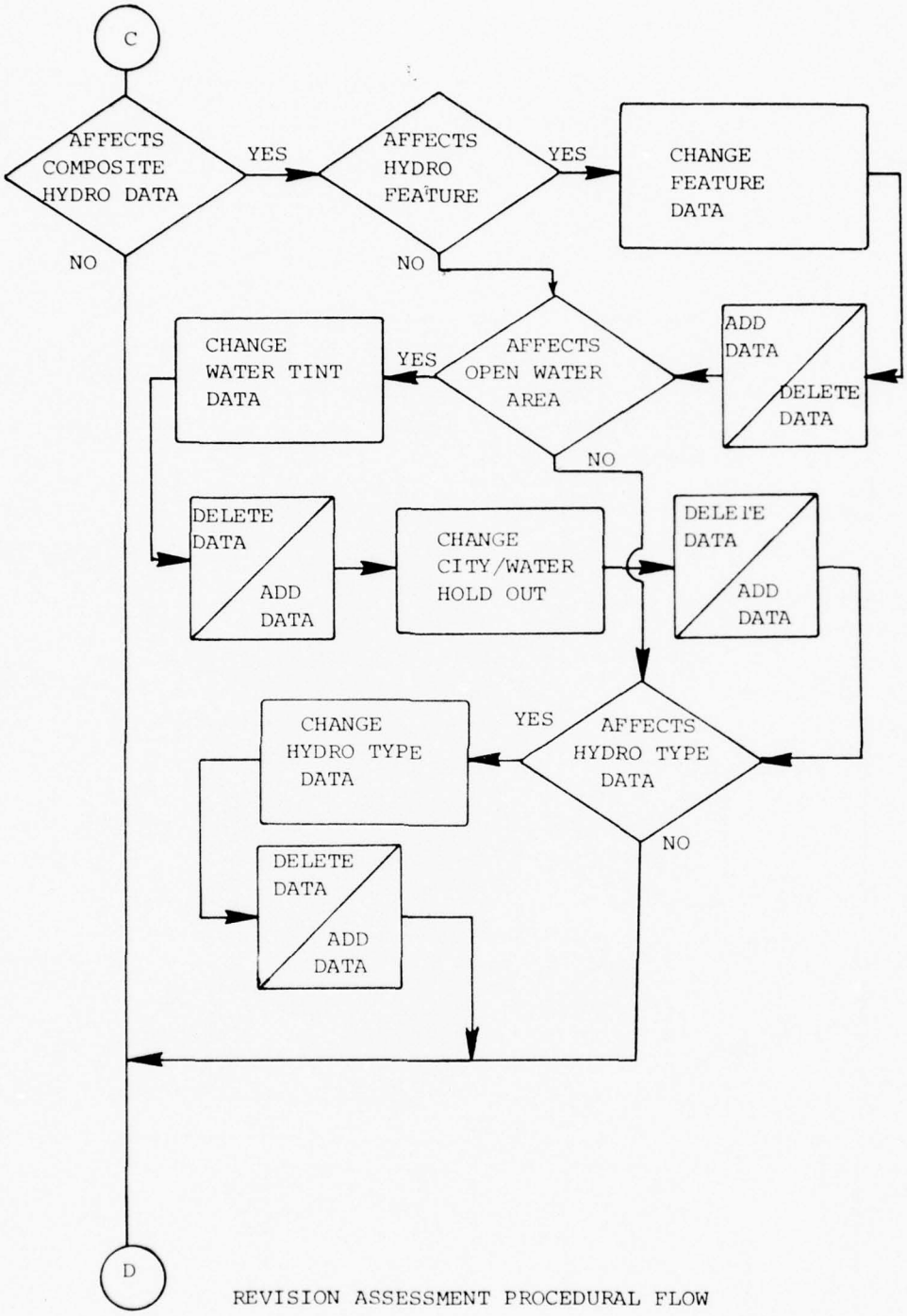


Figure No. 2-11 (page 1 of 5)



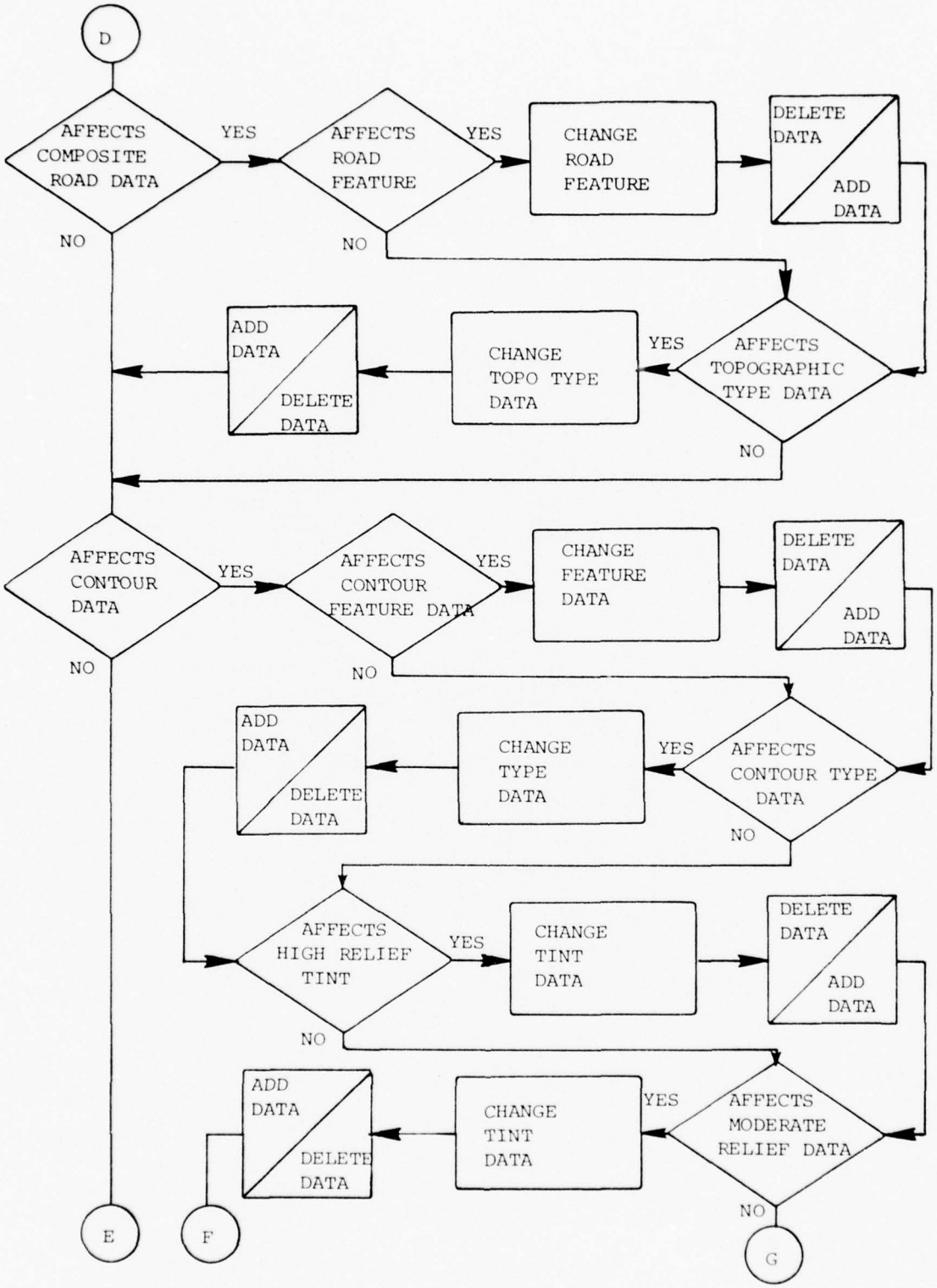
REVISION ASSESSMENT PROCEDURAL FLOW

Figure No. 2-11 (page 2 of 5)



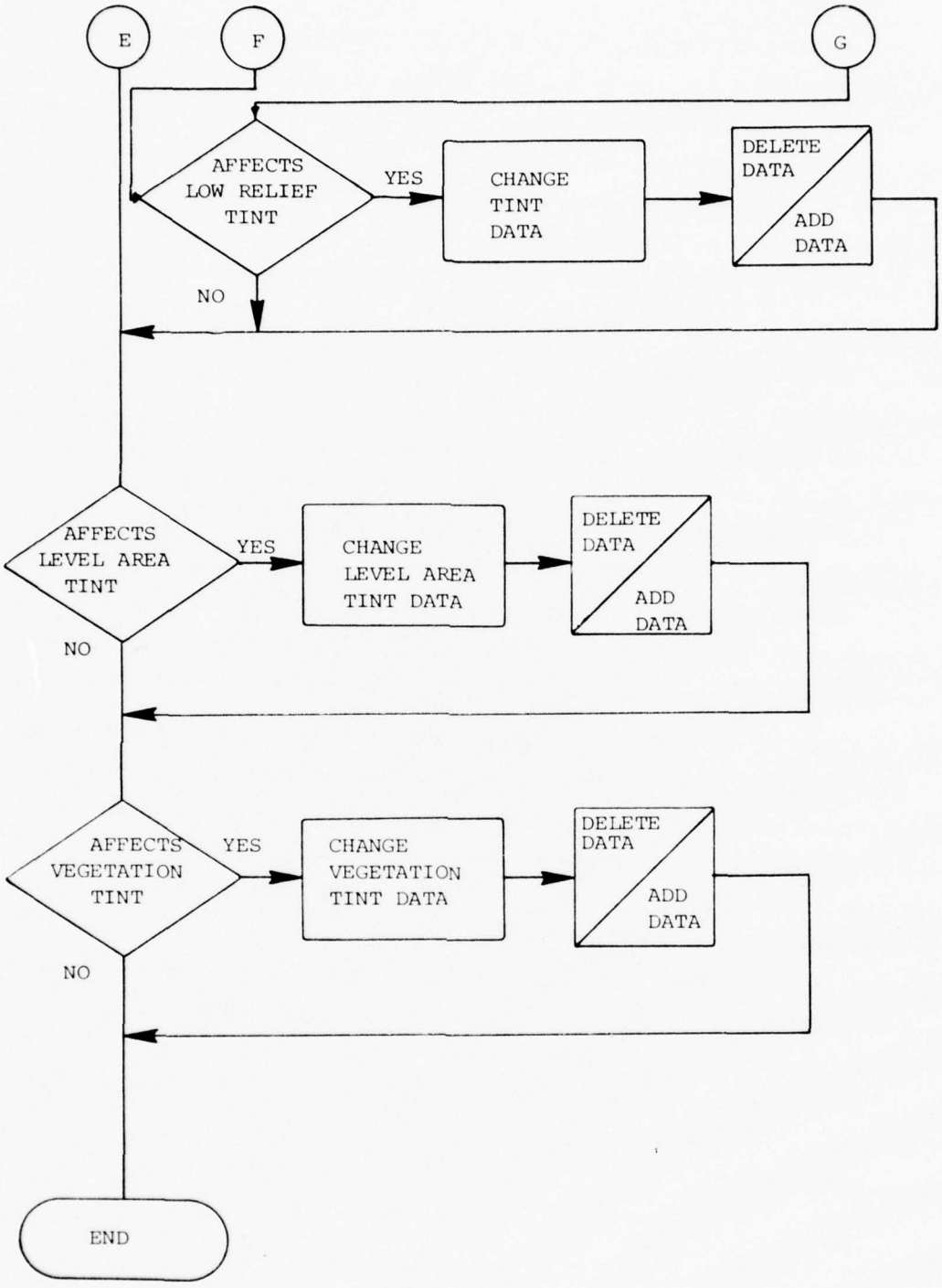
REVISION ASSESSMENT PROCEDURAL FLOW

Figure No. 2-11 (page 3 of 5)



REVISION ASSESSMENT PROCEDURAL FLOW

 Figure No. 2-11 (page 4 of 5)



REVISION ASSESSMENT PROCEDURAL FLOW

Figure No. 2-11 (page 5 of 5)

feature/data component overlays to be changed by the insertion of new data to that composite file. A consideration of each type of cartographic data must be made and where appropriate, corrective action taken. (In this illustration simply defined as eliminating old or erroneous data and inserting new data.) In most cases an update specification will affect only one feature of similar classification. However, in many cases, a chart product update will, although minor or singular in itself, affect several feature types and/or data components of a particular cartographic product.

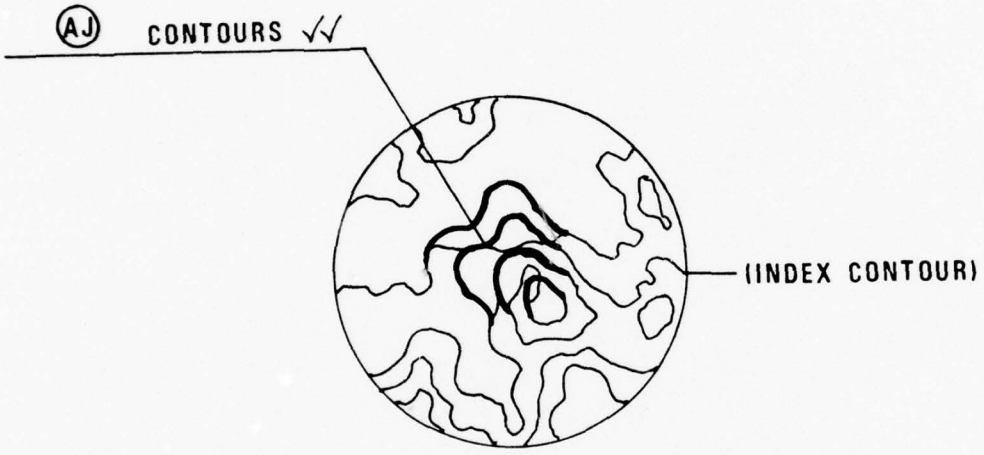
For the purposes of this effort, it was assumed that the overall revision assessment had been made through manual or automated means. The specific revision thereby being addressed. To facilitate revision method selection and development, it was necessary to establish those general functions required to effect an individual revision. Each revision call specified (paragraph 2.1 Figure No. 2-1) was plotted through the various step processes that would be required to effect the update. For general information, Figure No. 2-12 lists revision call symbology. Figure No. 2-13 through 2-18a illustrates specific revision calls and the resultant step process flow for revision action.

The delineation of method development was also envisioned as either a feature by feature revision process where each new piece of update data is interjected into the specific feature affected and consequently other feature and data components being adjusted as required. A work flow diagram of a feature by feature process is illustrated in Figure No. 2-19. An "area" type of revision procedure was considered. In the "area" revision method a specified section of a chart product is outlined and all feature data within that area is replaced with new revised data. A work flow for an area method of revision procedures is illustrated in Figure No. 2-20. This method was not pursued further during this project in view of the present capabilities of the LIS system to effect an area change through in-being programs of sectioning, panelling, merging, etc.

REVISION CALL SYMBOL

(A)	=	ADD
(AL)	=	ALIGN
(CG)	=	CHANGE
(AJ)	=	ADJUST
(D)	=	DELETE
√√	=	AS INDICATED

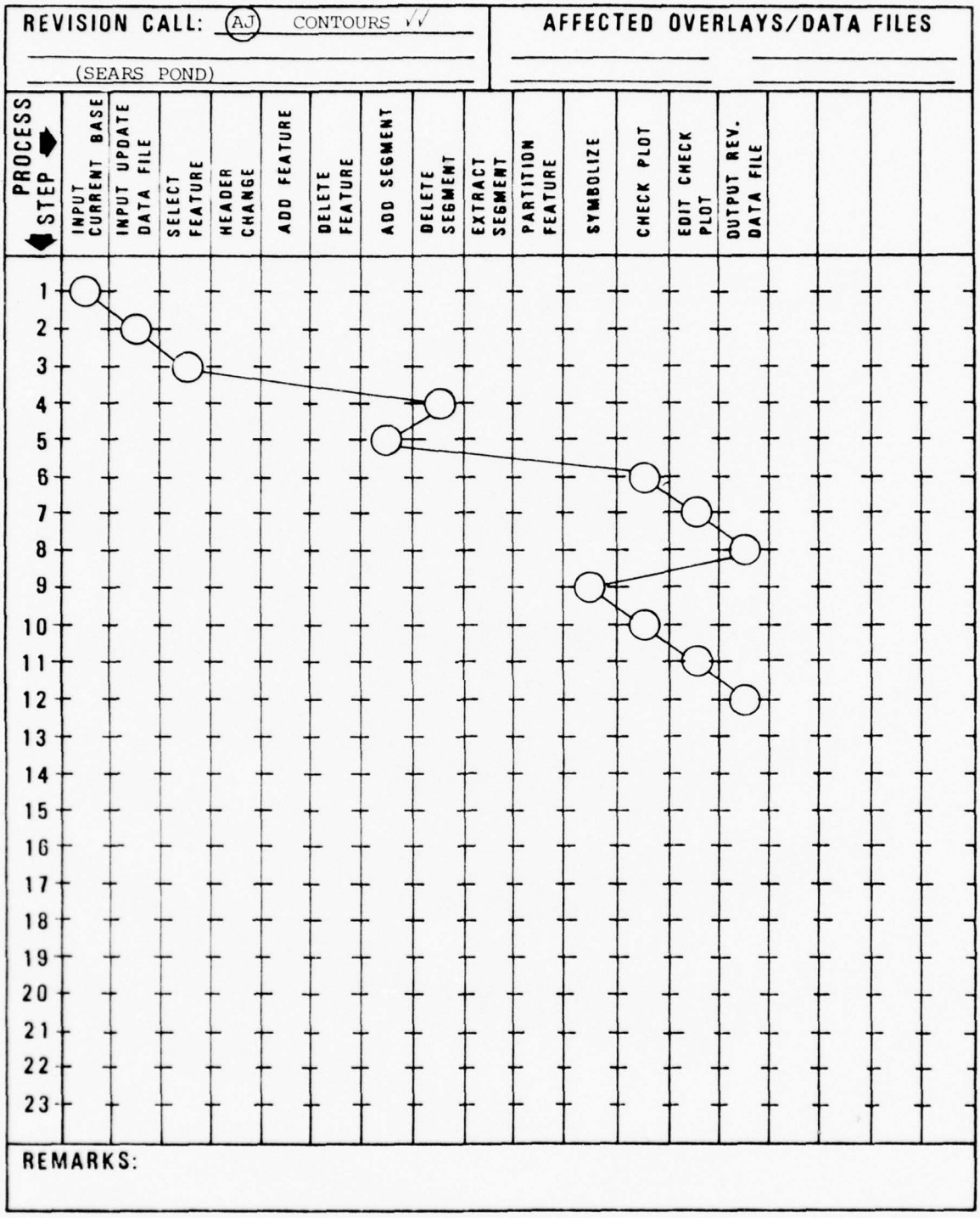
Figure No. 2-12



REVISION CALL 1

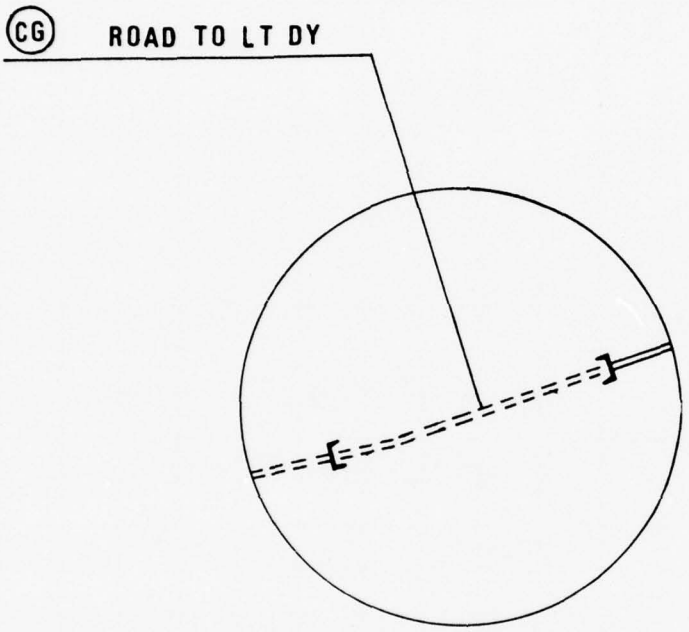
SEARS POND QUAD

Figure No. 2-13



DRT STEP PROCESS FLOW

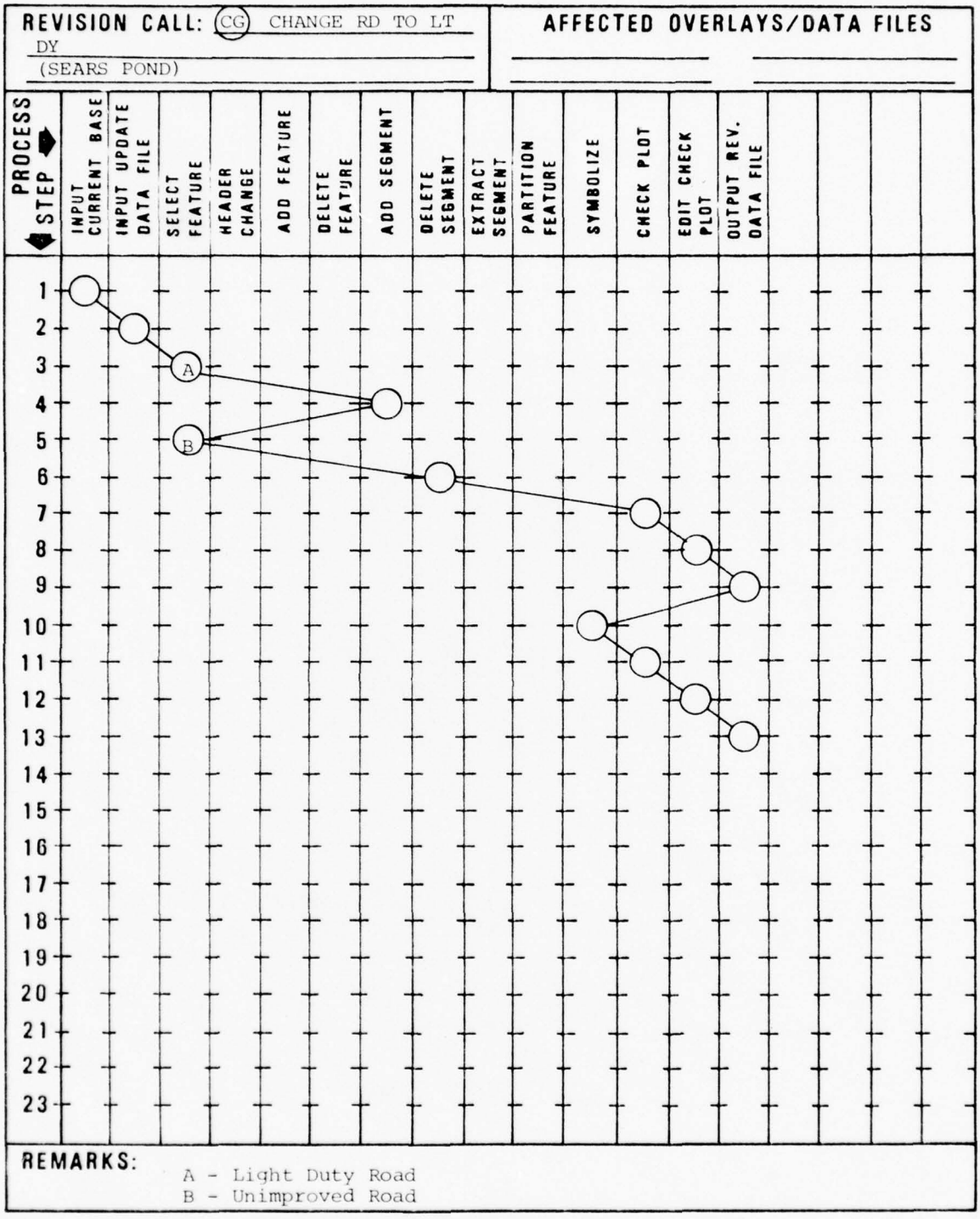
Figure No. 2-13A



REVISION CALL 2

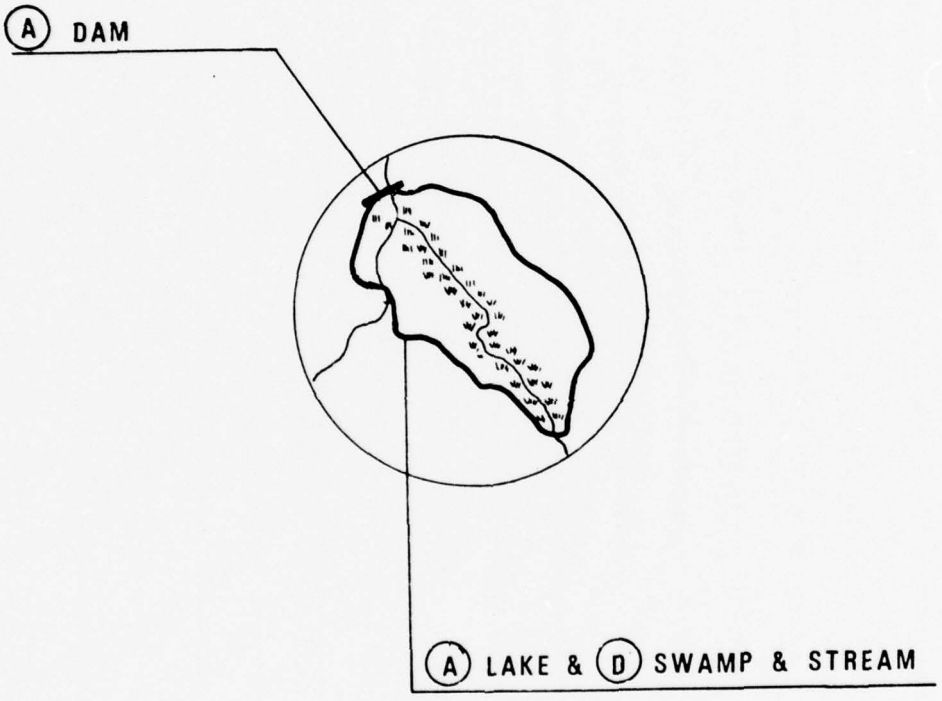
SEARS POND QUAD

Figure No. 2-14



DRT STEP PROCESS FLOW

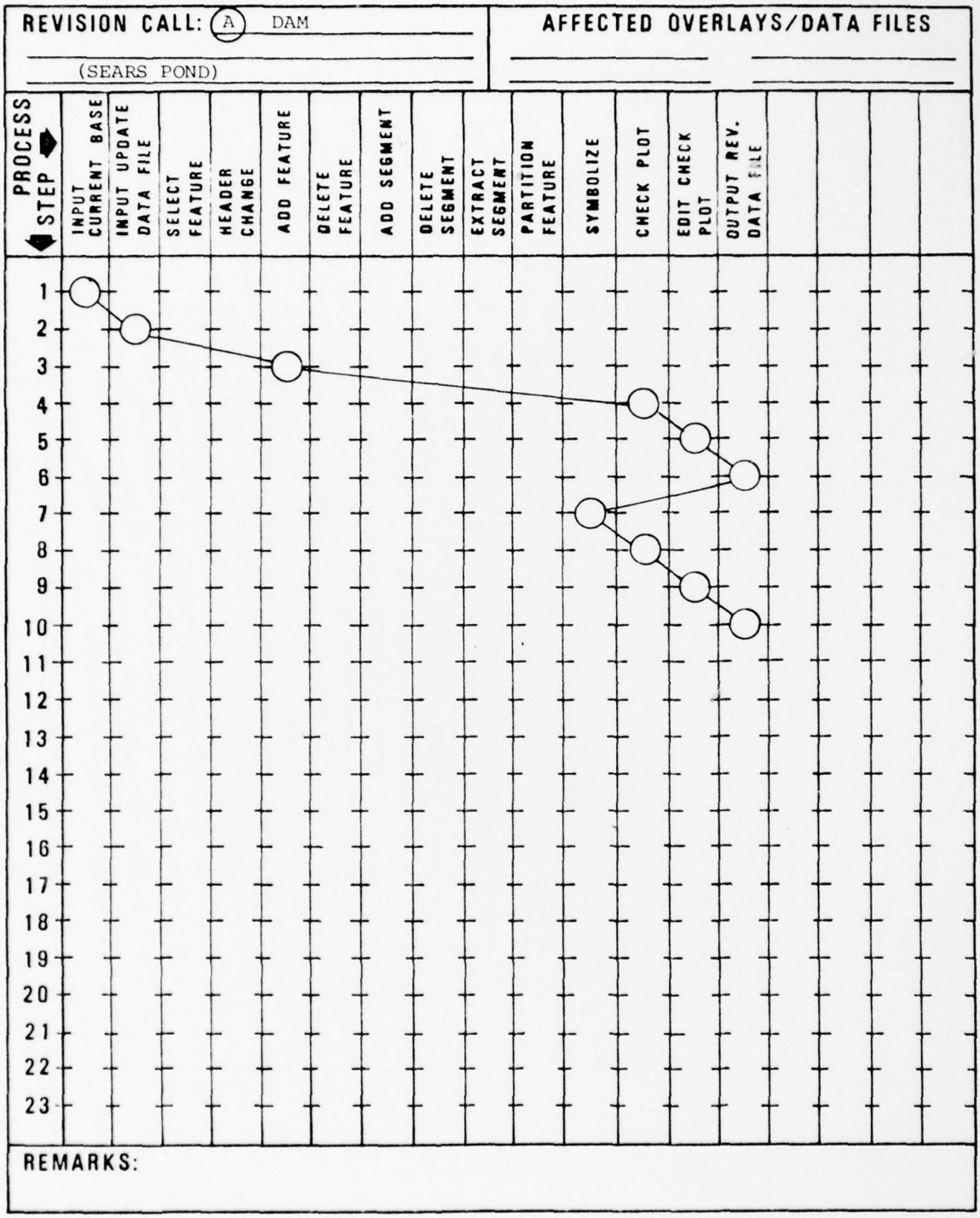
Figure No. 2-14A



REVISION CALL 3

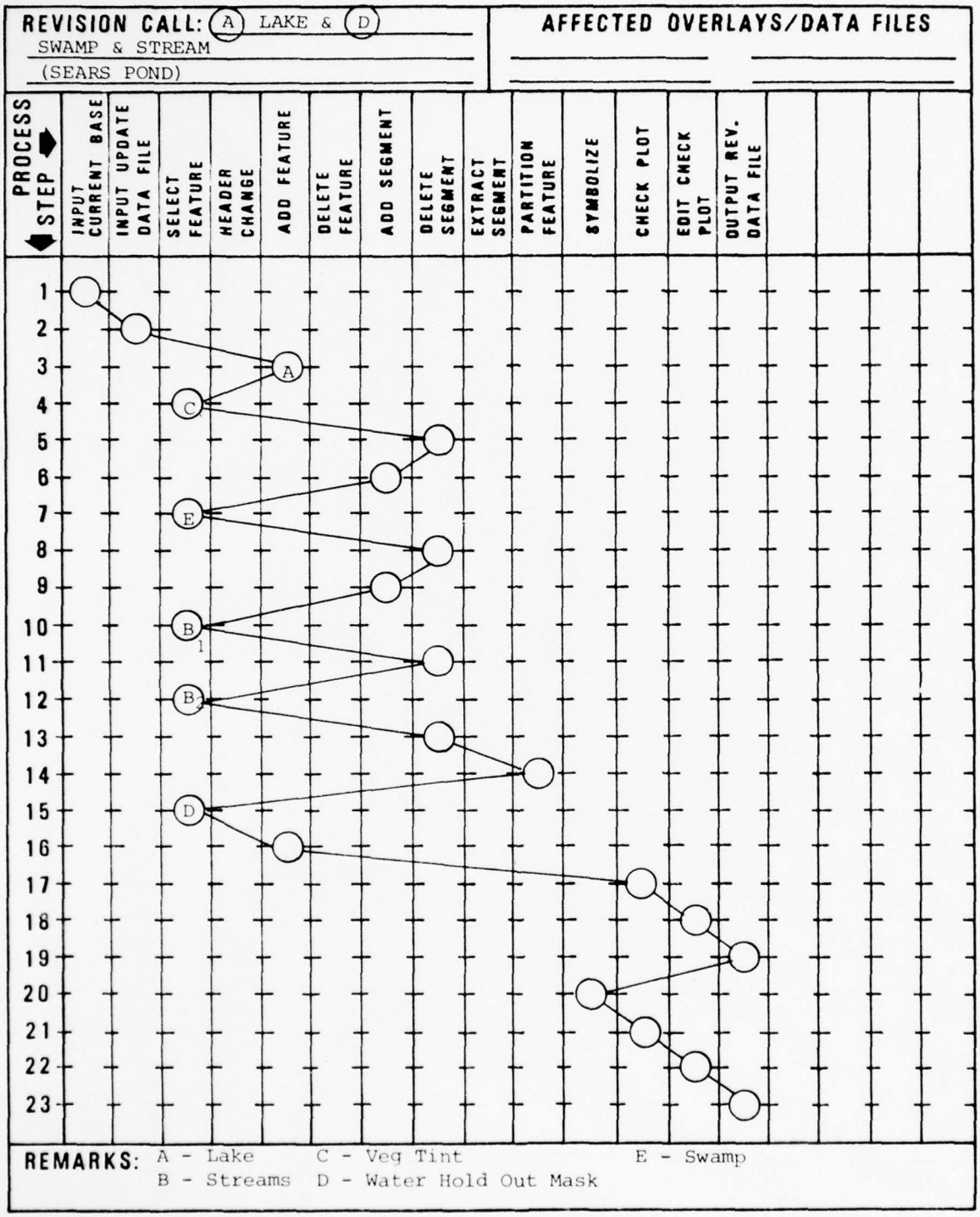
SEARS POND QUAD

Figure No. 2-15



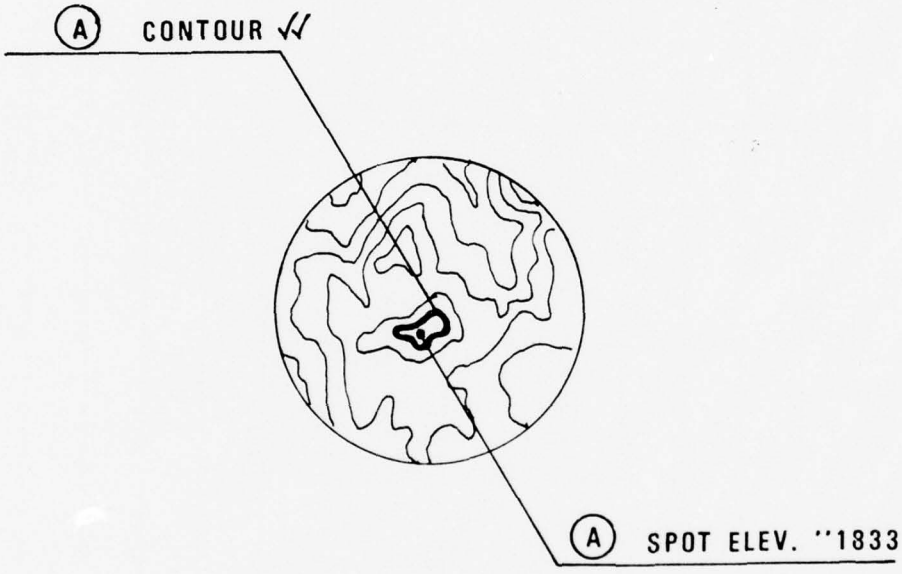
DRT STEP PROCESS FLOW

Figure No. 2-15A



DRT STEP PROCESS FLOW

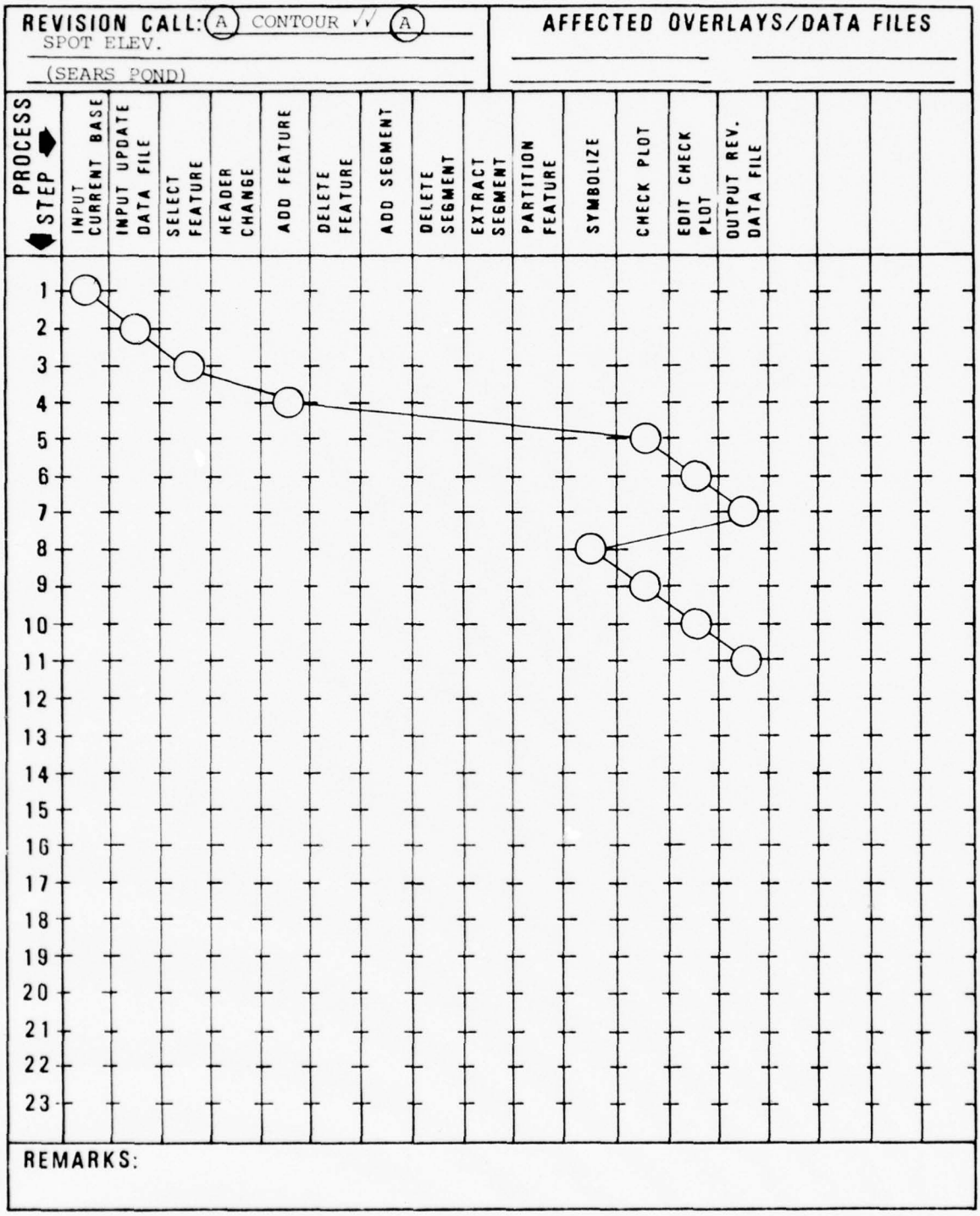
Figure No. 2-15B



REVISION CALL 4

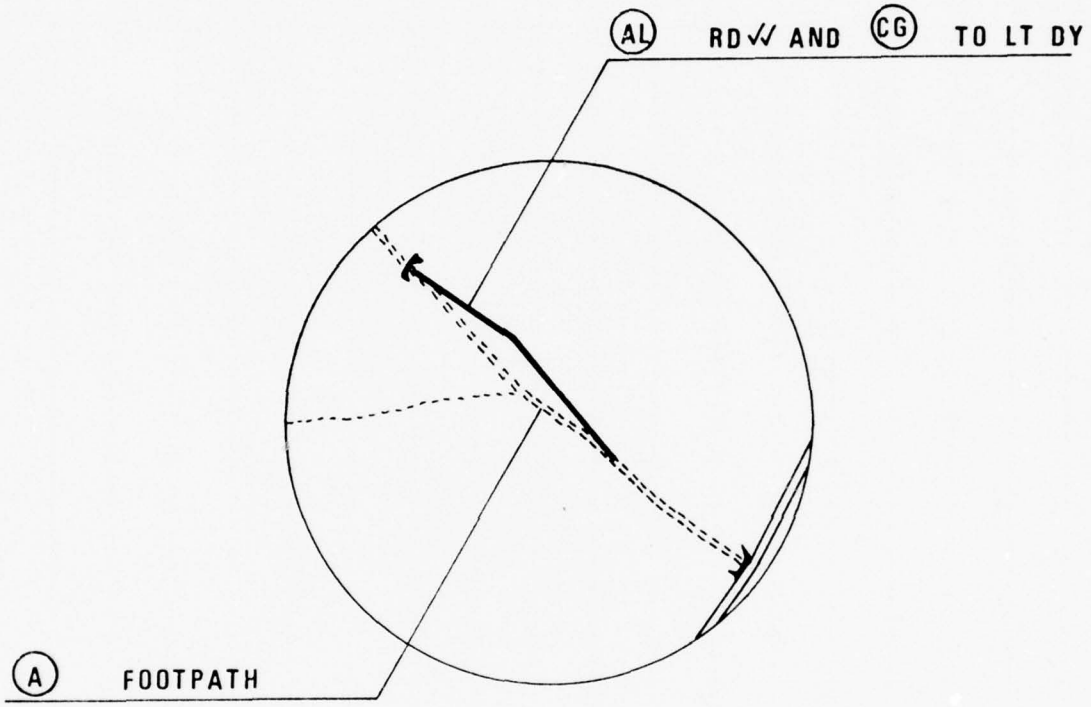
SEARS POND QUAD

Figure No. 2-16



DRT STEP PROCESS FLOW

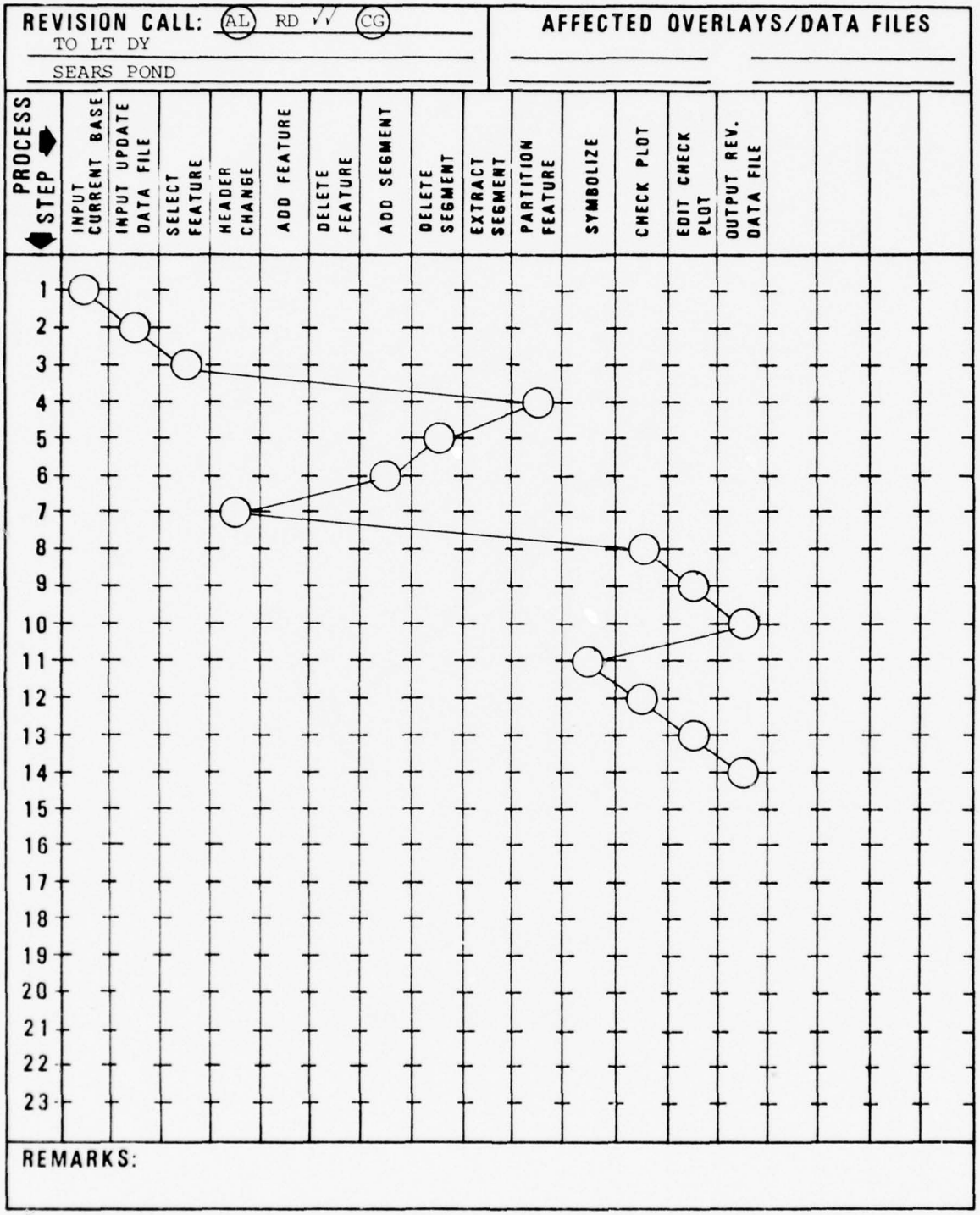
Figure No. 2-16A



REVISION CALL 5

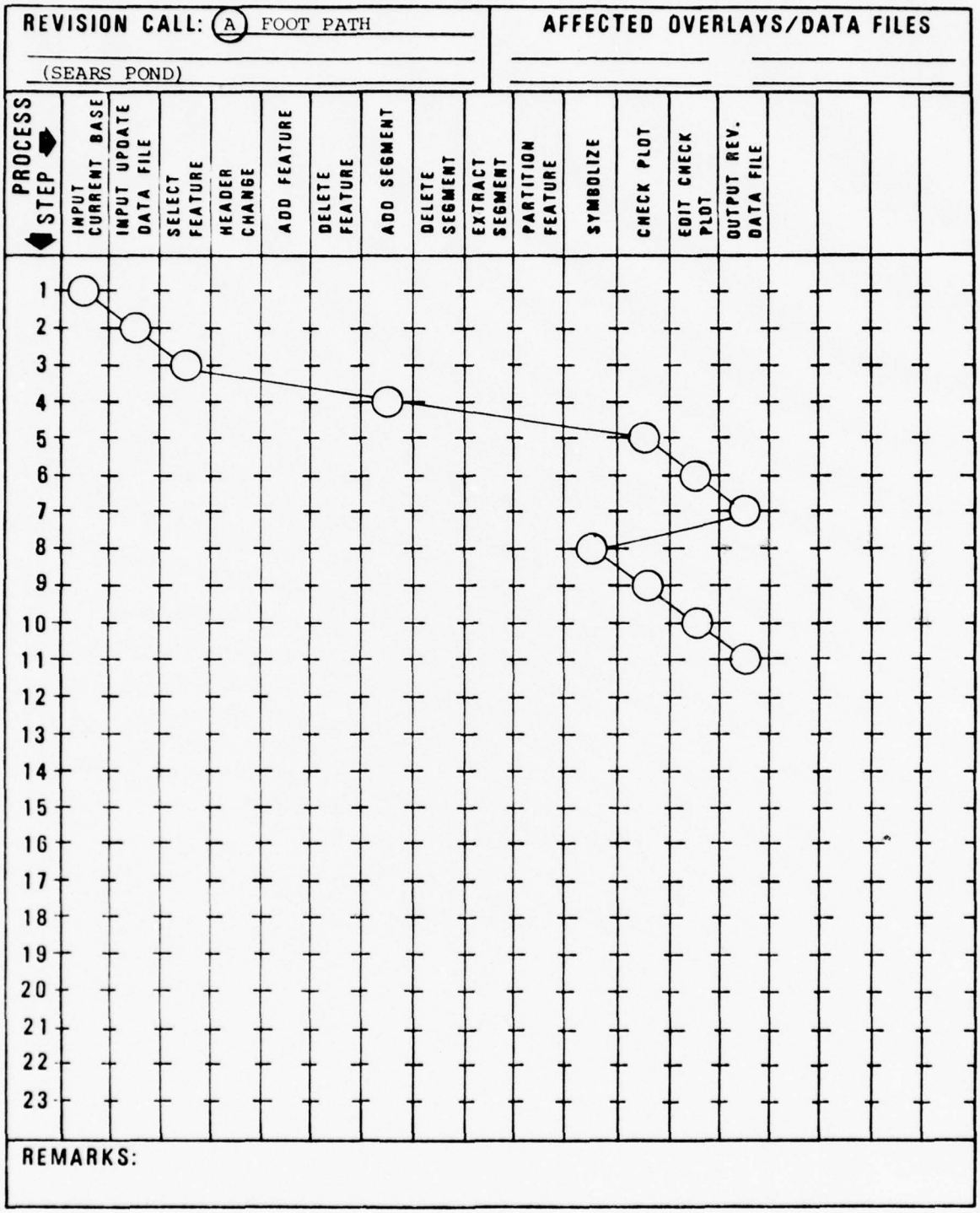
SEARS POND QUAD

Figure No. 2-17



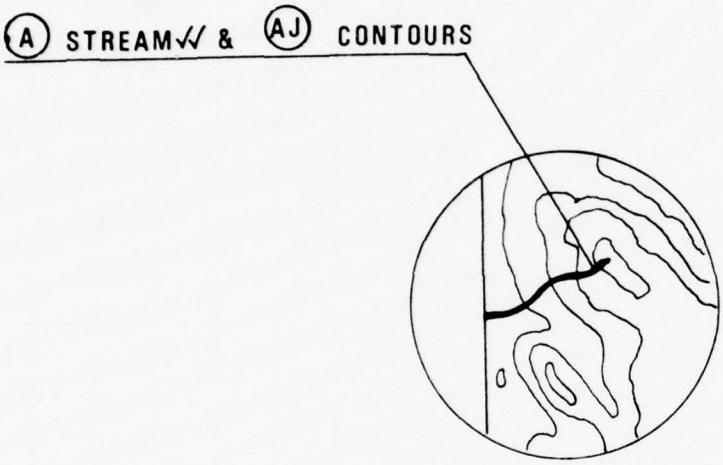
DRT STEP PROCESS FLOW

Figure No. 2-17A



DRT STEP PROCESS FLOW

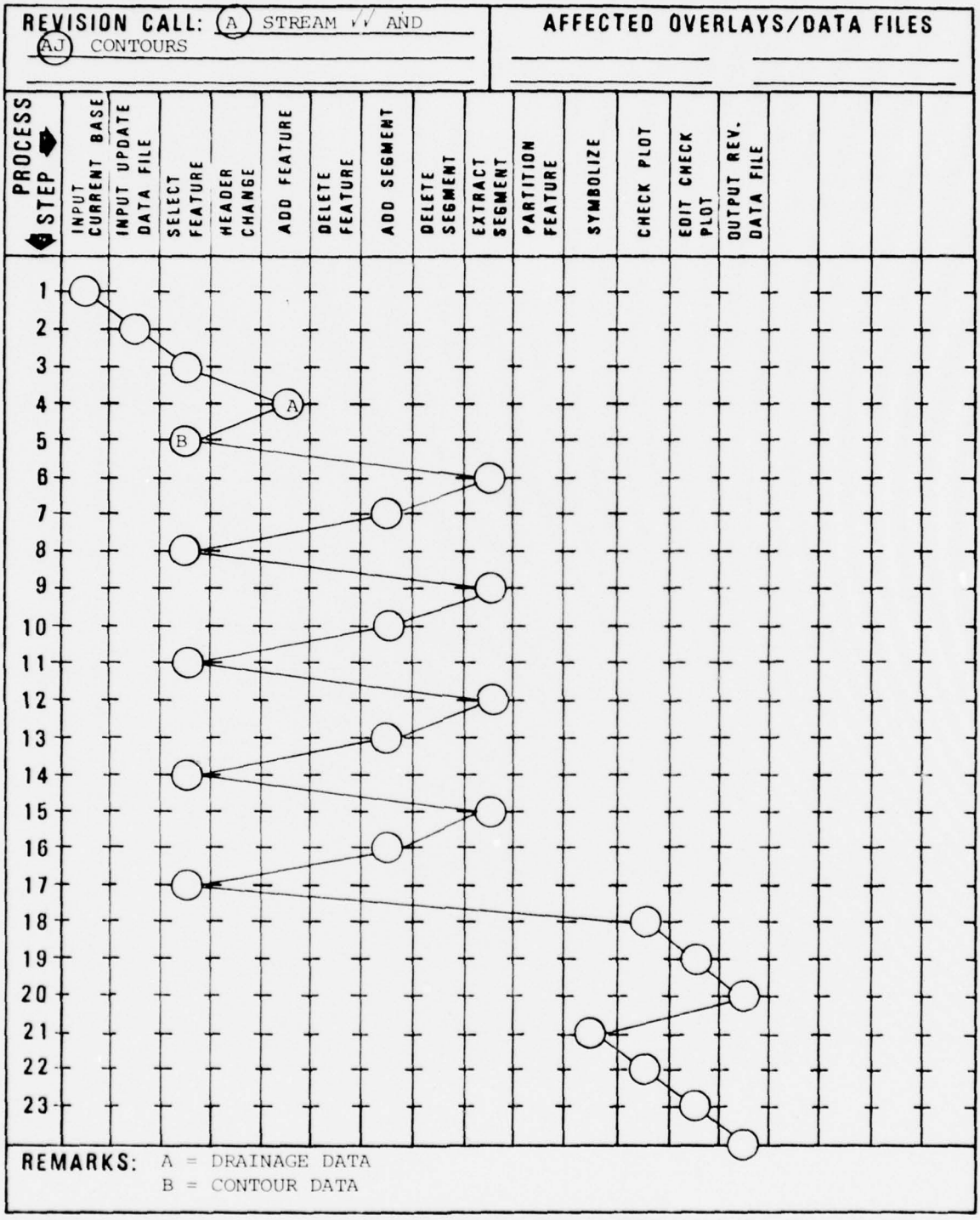
Figure No. 2-17B



REVISION CALL 6

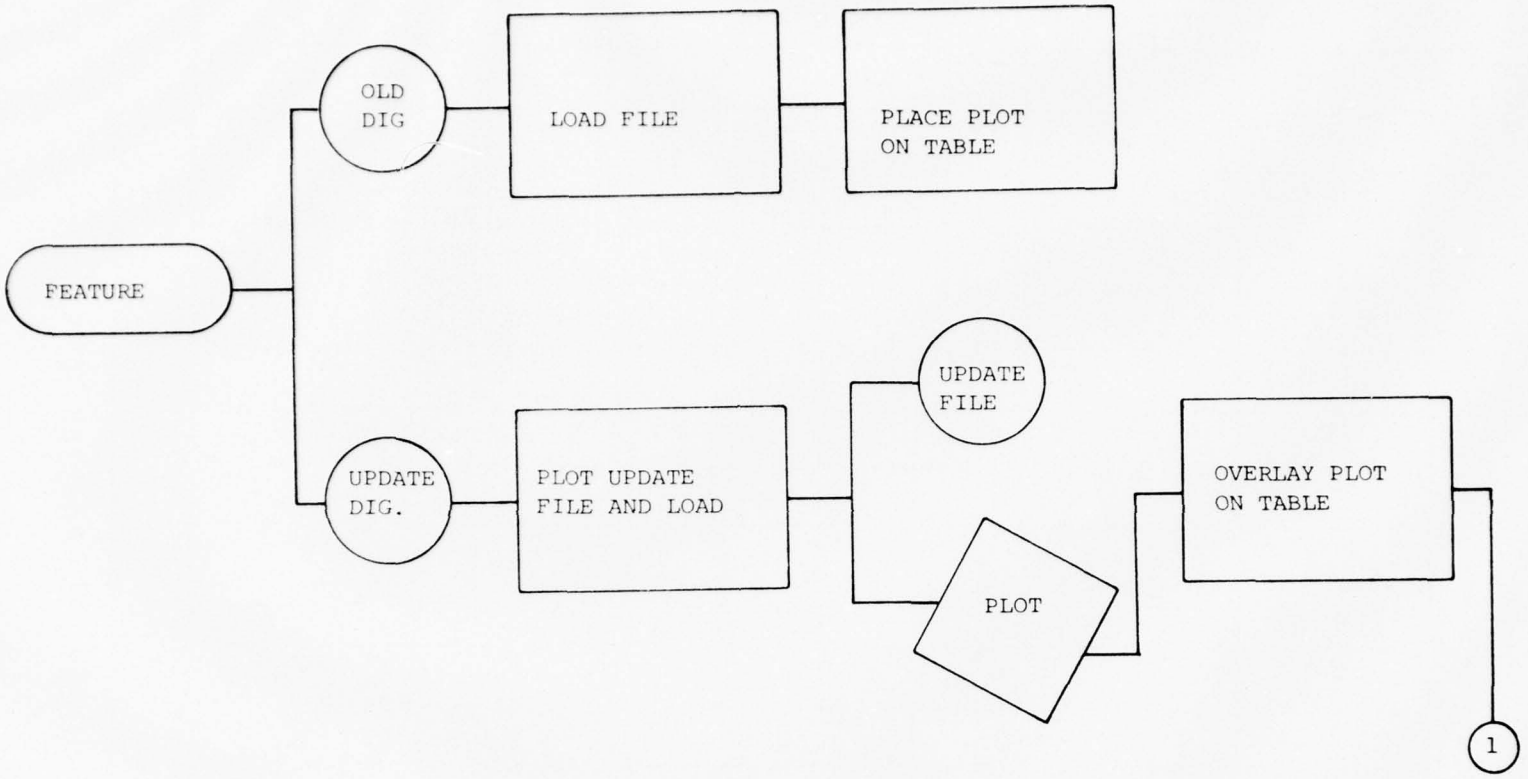
SEARS POND QUAD

Figure No. 2-18



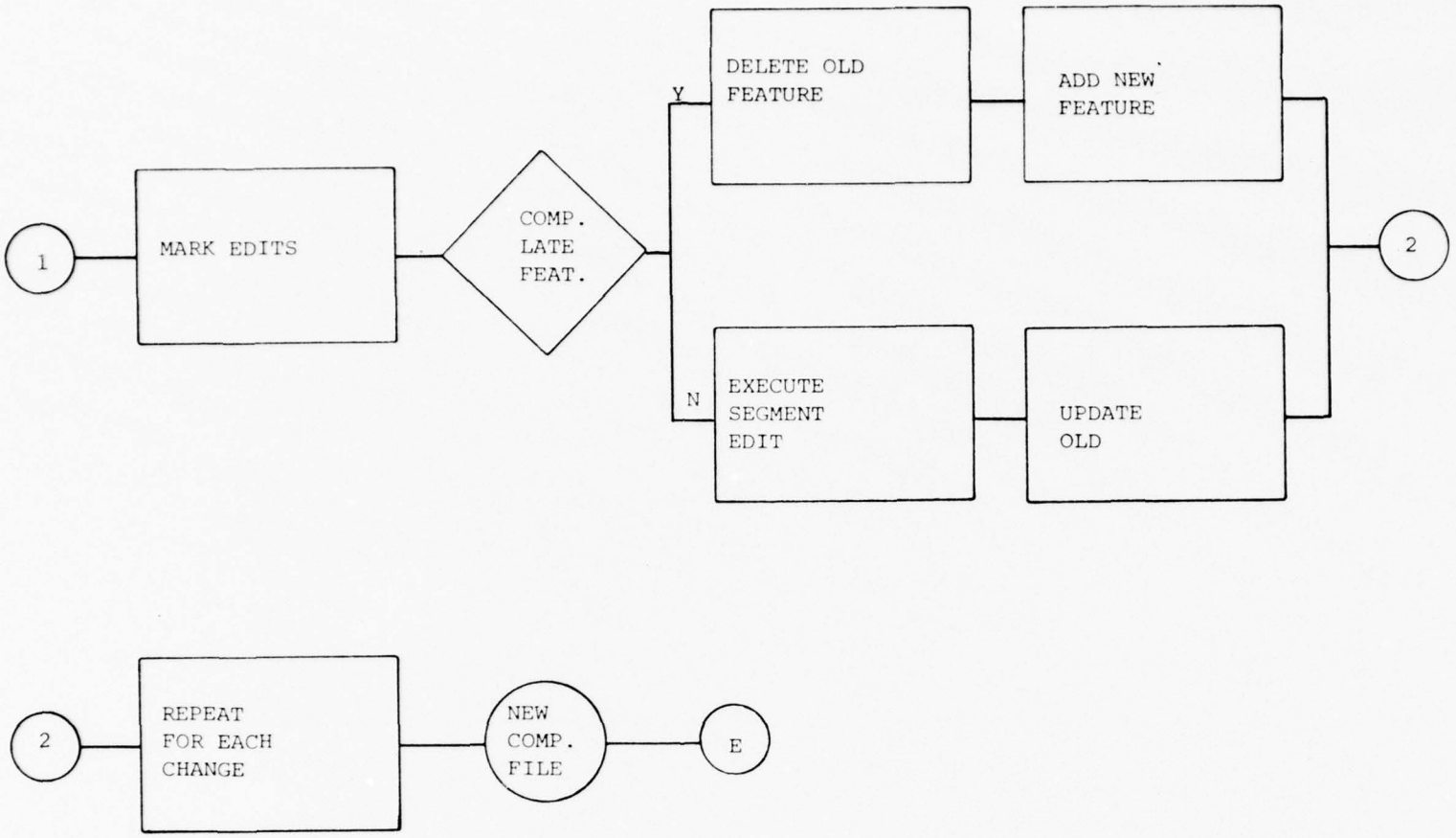
DRT STEP PROCESS FLOW

Figure No. 2-18A



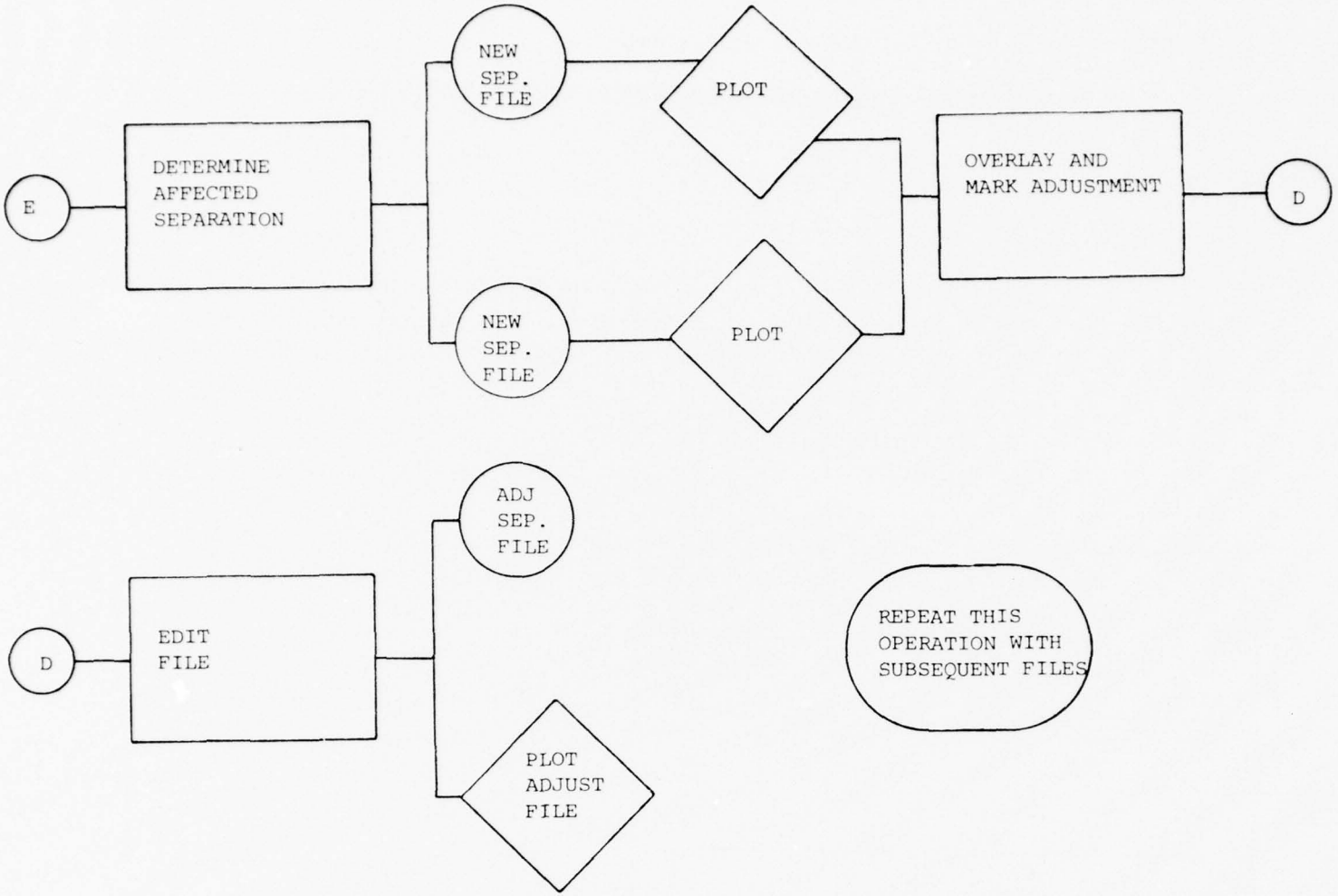
DIGITAL REVISION "FEATURE" FUNCTIONAL OVERVIEW

Figure 2-19



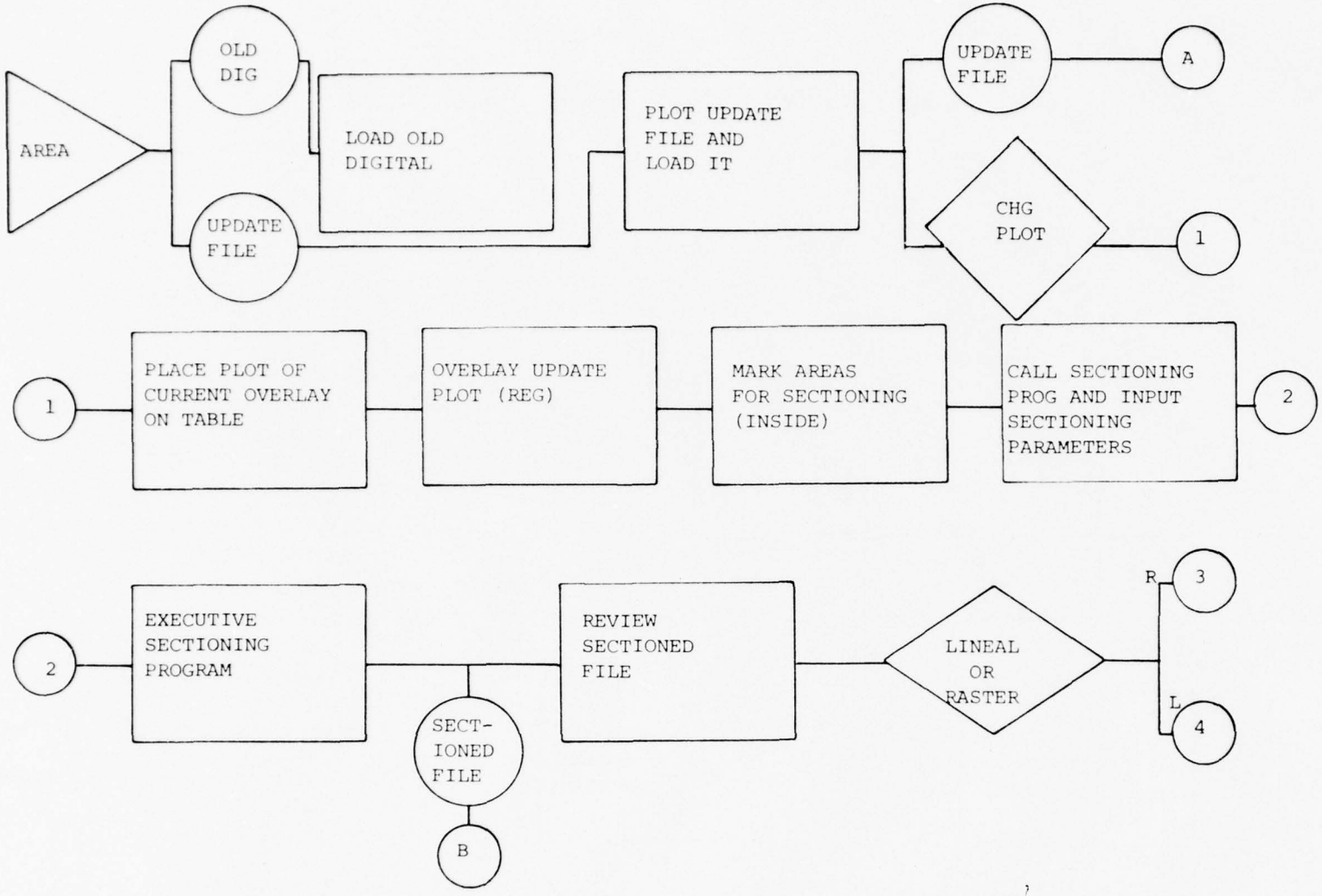
DIGITAL REVISION "FEATURE FUNCTIONAL OVERVIEW

Figure 2-19 (Con't)



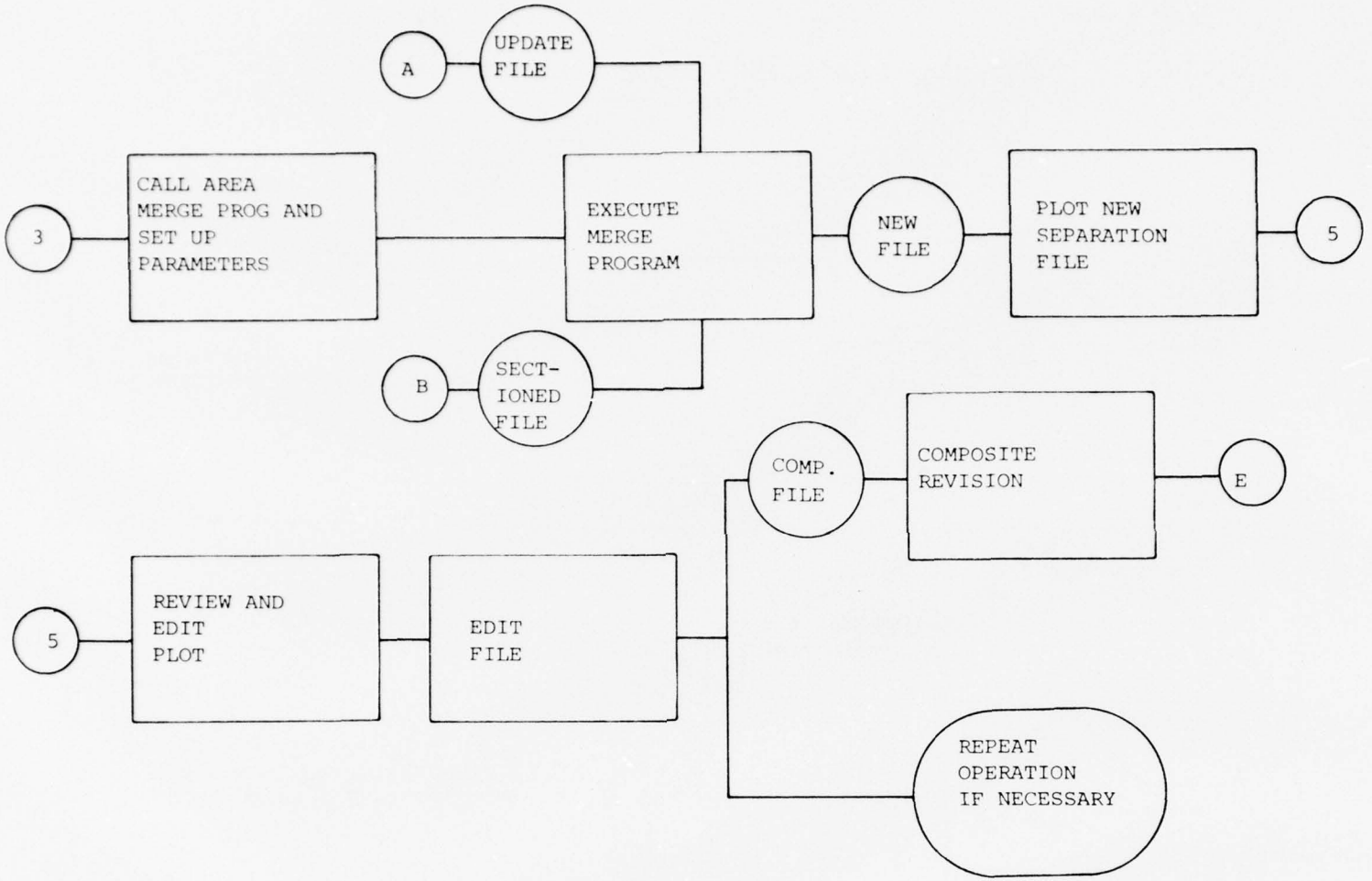
DIGITAL REVISION "FEATURE" FUNCTIONAL OVERVIEW

Figure 2-19 (Con't)



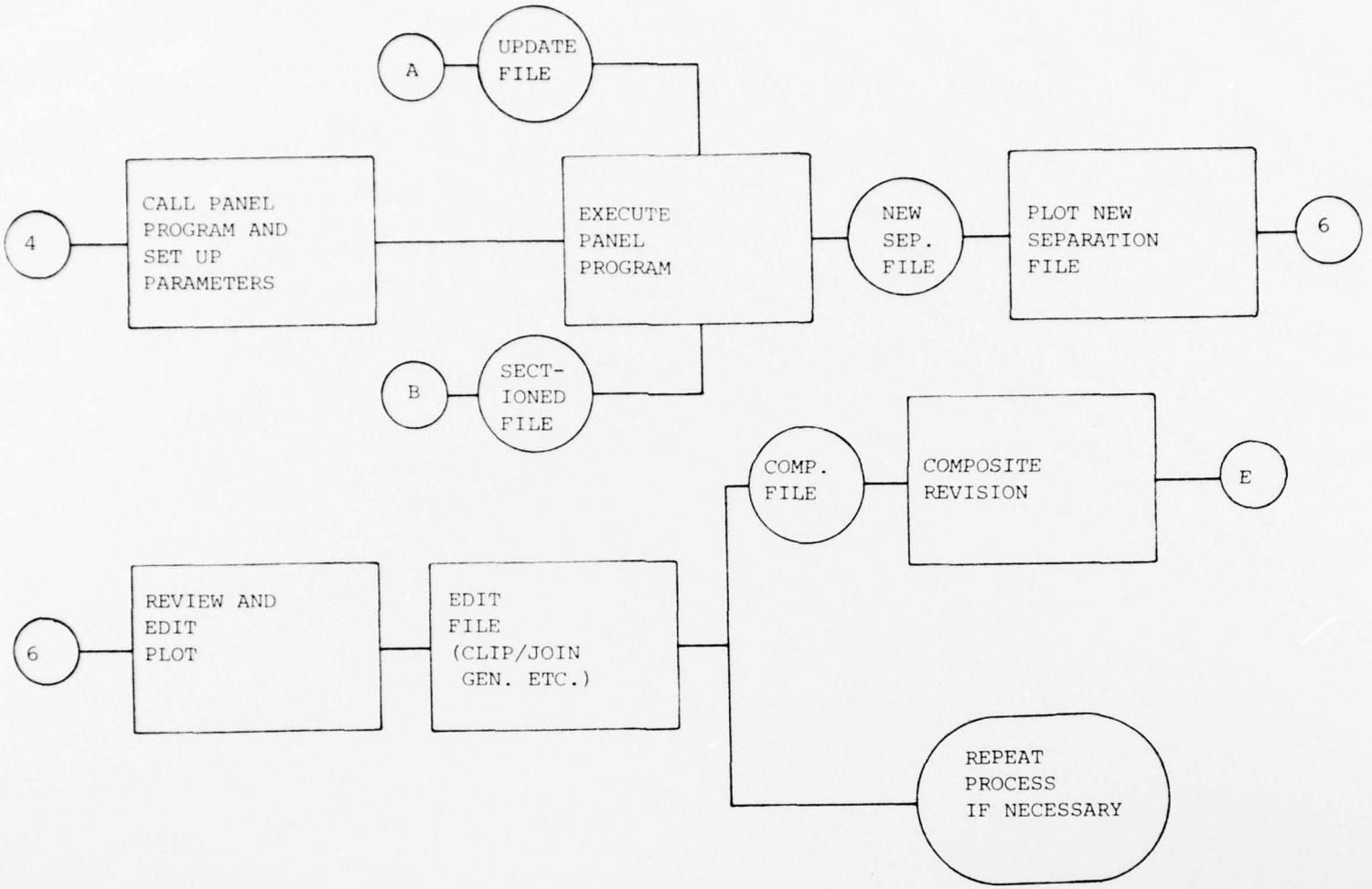
DIGITAL REVISION "AREA" FUNCTIONAL OVERVIEW

Figure 2-20



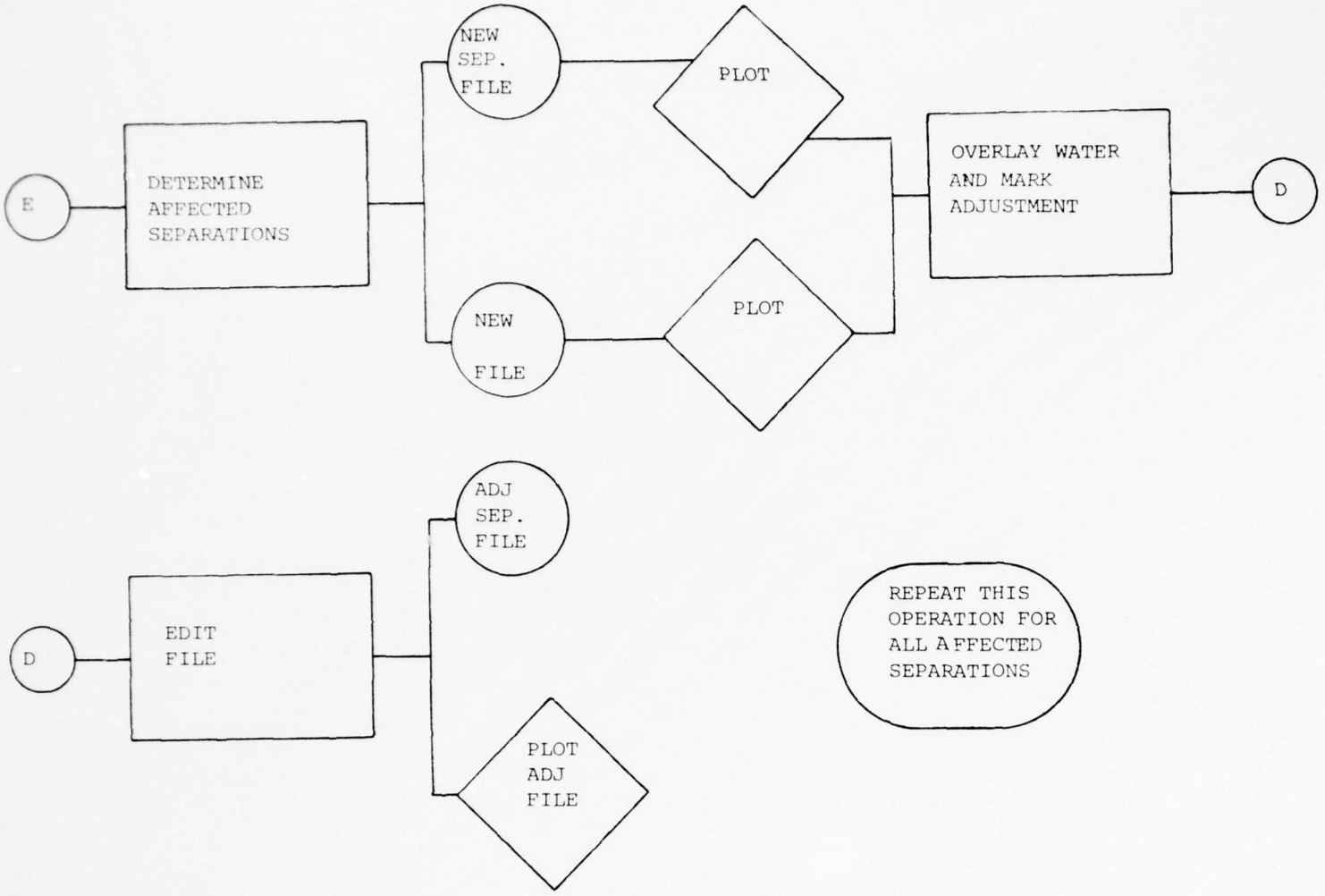
DIGITAL REVISION "AREA" FUNCTIONAL OVERVIEW

Figure 2-20 (con't)



DIGITAL REVISION "AREA" FUNCTIONAL OVERVIEW

Figure 2-20 (Con't)



DIGITAL REVISION "AREA" FUNCTIONAL OVERVIEW

Figure 2-20 (Con't)

SECTION III

METHOD DESIGN

3.1 The selected approach taken to specify the programs necessary for digital revision techniques was to eliminate all programming that will not directly be used for a batch editing program. Since the LIS was used to develop the software, all data inputs were via existing software which required that:

- o All features digitized must be described by at least their class, type, and subtype.
- o Each point or lineal string must have a description.
- o The text field of each feature's description will accept user free form data.

Specifically, the method used requires that two LIS format files exist on disk. One of the files is the original data file and the second file contains the updates for the original file. The software inputs the original file and creates a third (output) file which contains the updated original data file. The original data file is created the same as any normal LIS data file. The software creates the updated file from the file name furnished by the user. The creation of the update file is discussed below. Figure No. 3-1 illustrates the overall automated revision process.

The update file contains the following functions and subfunction code(s) in the text field of each update feature.

Functions

CF Change description of existing feature.

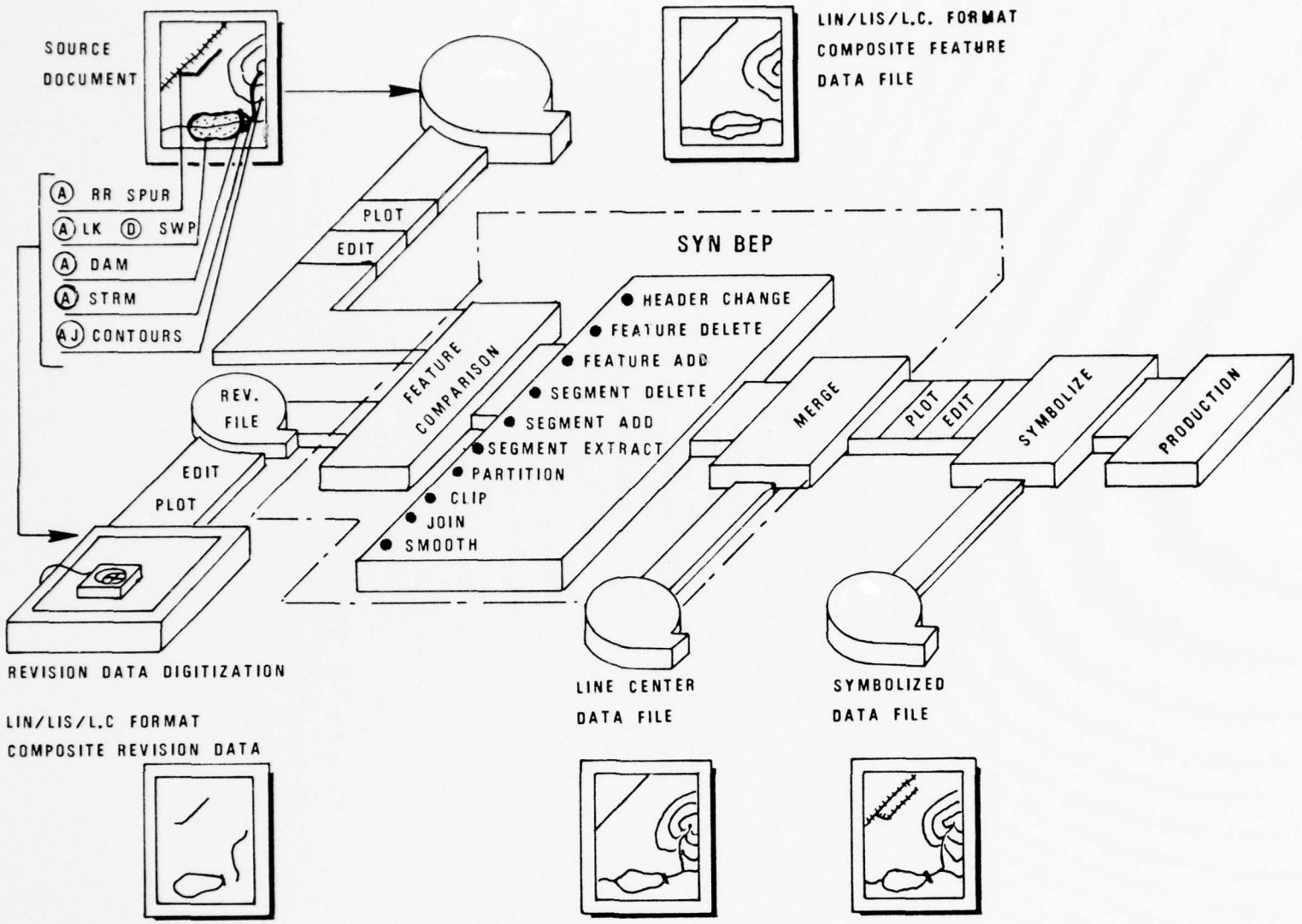
CS Change description of existing segment.

AF Add a new feature.

AS Add a new segment.

DF Delete existing feature.

DS Delete existing segment.



DRT AUTOMATED REVISION PROCESS

Figure 3-1

Subfunctions

IE Join ends of segment to existing feature.

IC Clip all features of the same class that start or end on old segment so they do not cross the new segment.

IJ Extend all features of the same class that begin or end on old segment so they begin or end on new segment.

EA Extract all feature or segments that fall within the closed feature added with a AF function and digitized in a counter clockwise direction.

EE Same as EA except the user can specify the class, type, and subtype of features that should not be deleted.

EI Same as EE except the user can specify the class, type and subtype of features that should be deleted.

ER Same as EA except the user can rename the segments or features that totally fall within the closed feature.

DC Stream added, so create contour depression. The stream must be digitized in the direction of the water flow.

Figure No. 3-2 illustrates the detail of feature description, number of point(s), and subfunction that can be used with each function.

Figure No. 3-3 illustrates the usable functions and combination with their anticipated results and usage.

The delimiters used to separate the functions and subfunctions are:

- A colon to separate each function and subfunction.
- A semicolon to separate the subfunctions from each description field.
- A comma to separate each description.
- A space to separate each description level.
- A period to end the command string.

FUNCTIONS	FEATURE DESCRIPTION REQUIRED		DIGITAL POINTS REQUIRED			SUBFUNCTIONS THAT MAY BE COMBINED WITH A FUNCTION		
	COMPLETE	CLASS, TYPE, & SUBTYPE	1 POINT	2 END POINTS	LINEAL STRING	IE IC IJ	EE* EA EI ER	DC
CF	✓		✓					
CS	✓			✓				
AF	✓				✓		✓	✓
AS	✓				✓	✓		
DF		✓	✓					
DS		✓		✓				

*Applies only to closed features

DIGITAL REVISION TECHNIQUES
FUNCTION USE DATA

Figure 3-2

FUNCTIONS ALLOWED	RESULTS OF FUNCTIONS	DIGITIZATION REQUIREMENT	FEATURE DESCRIPTION REQUIRED
CF:AS.	Change description of existing feature and join it to identical feature in master file	Select 1 Point on feature	Complete
CF.	Change description of existing features	Select 1 point on the feature	Complete
CS:AS.	Change description of existing segment and add it to existing feature	Select 2 end points of segment	Complete
CS:AF.	Change description of existing segment and make it a new feature	Select 2 end points of segment	Complete
AF.	Add a new feature	All of feature	Complete
AS.	Add a segment to existing feature	All of segment	Class, type and Subtype
AS:DS.	Add a segment to existing feature and delete segment with the same 2 end points	All of segment	Class, type and subtype
DS.	Delete segment of existing feature	Select 2 end points of segment	Class, type and subtype
DF.	Delete feature	Select 1 point on feature	Class, type and subtype

DIGITAL REVISION TECHNIQUES
FUNCTION RESULT DATA

Figure 3-3

Example:

The user wants to add a closed feature and rename all feature segments within the area with a class of 1, type of 2 to be a class of 1 and type 3.

First the user will describe the closed feature and insert the below function string before digitizing the feature.

AF:ER;1,2,1 3.

SECTION IV

SOFTWARE DEVELOPMENT

4.0 Overview

The Batch Edit Program is a concept to provide a method of editing digitized data and reducing the on-line time required to edit an existing file from any source. The experiments were run on the Lineal Input System (LIS) PDP-15 using the following three standard formatted vector data files.

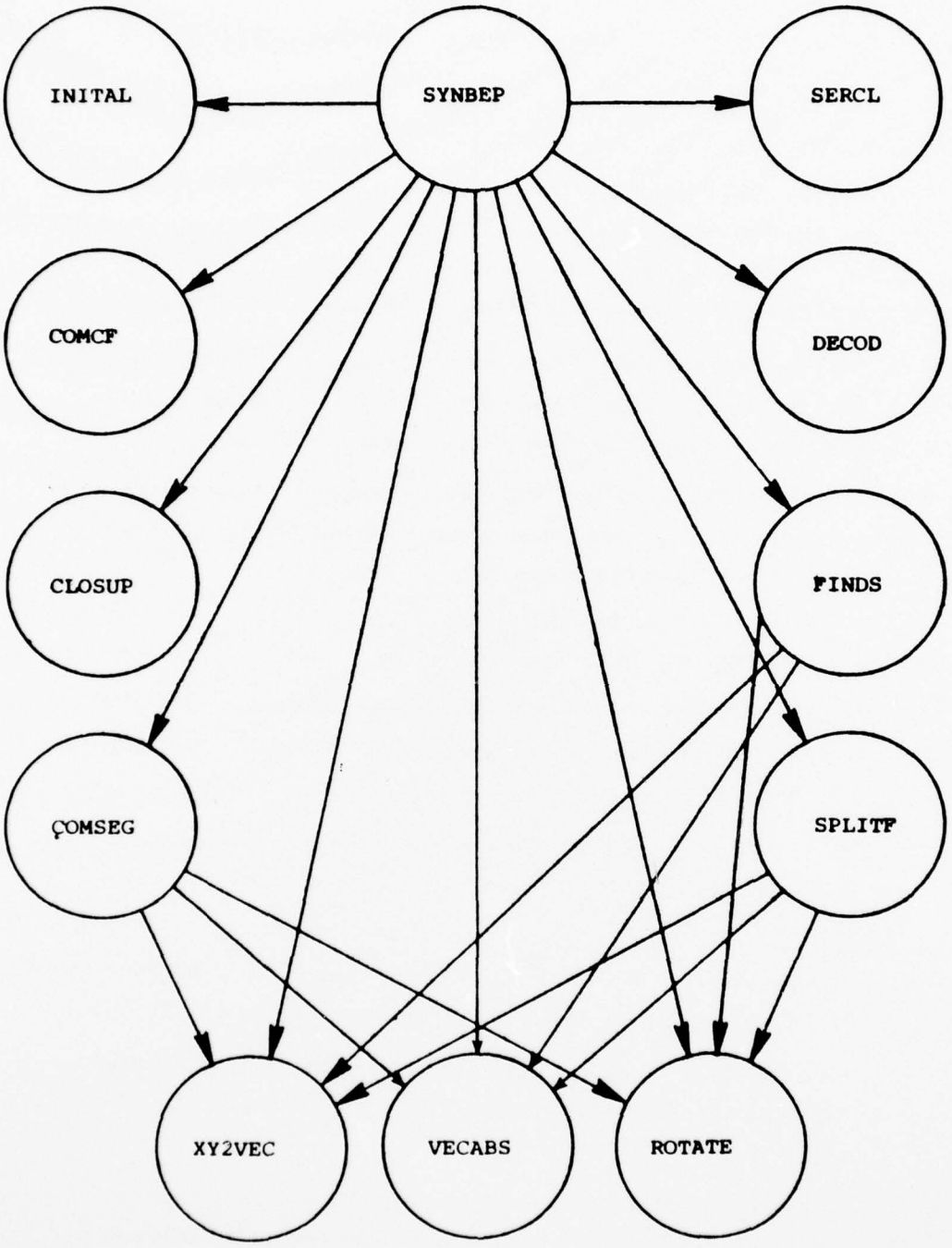
- o Master file containing the digital data file.
- o Edit file containing the corrections to the Master file.
- o Output file containing the edited Master file data.

Figure No. 4-1 defines the overall structure of the Batch Edit Program. The remainder of this section is dedicated to the functional description of each routine in the Batch Edit Program.

4.1 SYNBEP Routine

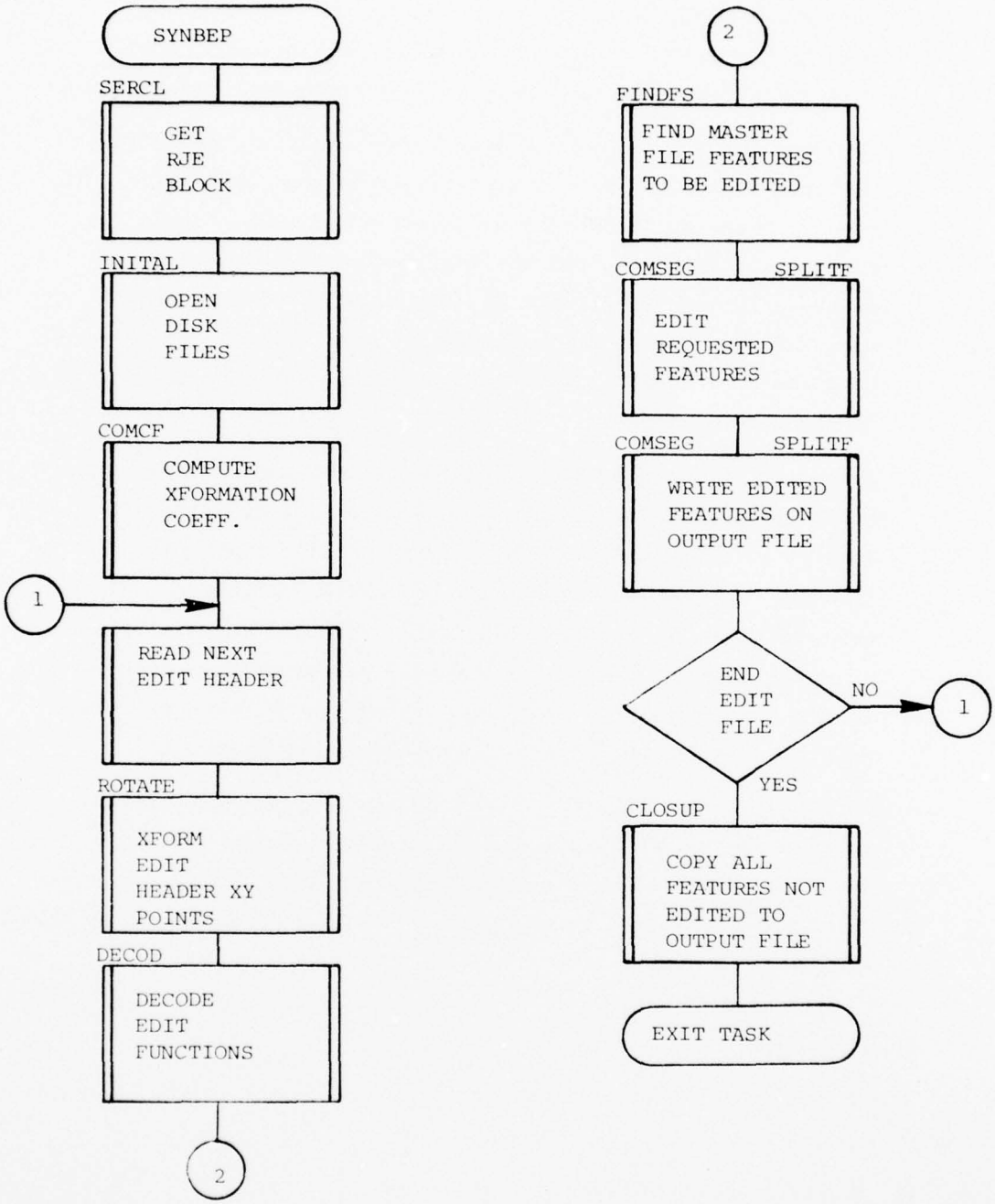
SYNBEP is the controlling routine for the Batch Edit Program and calls each of the subroutines when their specific function is required. Functionally, SYNBEP (Reference Figure No. 4-2) performs the following operations.

- o Calls subroutine SERCL to obtain the remote job entry (RJE) block. This data block contains the names of the disk files and is in standard LIS format.
- o Passes the file information to subroutine INITAL to open the disk files and copy the control records to the output file.
- o Subroutine COMCF is called to compute the transformation coefficients necessary to transform the Edit file to the Master file.
- o The next edit feature header record is read into core and the first and last X,Y points are transformed by subroutine ROTATE.



BATCH EDIT PROGRAM STRUCTURE

Figure No. 4-1



SYNBEP FUNCTIONAL FLOW

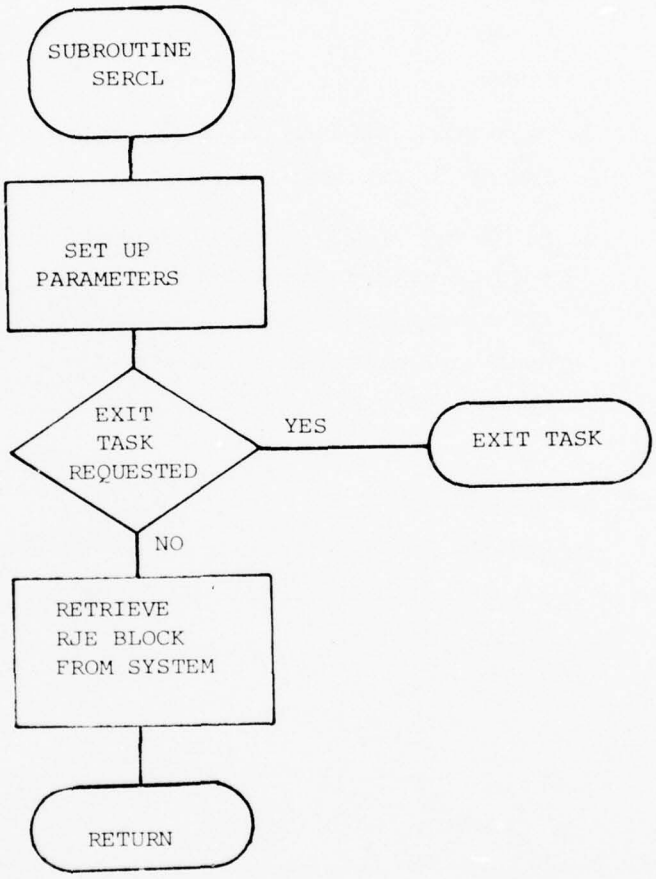
Figure No. 4-2

- o Subroutine DECOD is called to interpret the edit request which are embedded in the text field of the header record. This subroutine will set flags that correspond to the function.
- o If a new feature is to be added, SYNBEP reads the new edit feature, transforms it, then writes it on the output file. If a current master feature is to be edited, a call is made to subroutine FINDFS to find the feature and the exact location of the point(s) that start and end the edit segment. When more than one master file feature is to be edited, then a second call would be made to FINDFS to locate the second feature involved in the requested edit.
- o Depending on the edit function(s) a call is made to subroutine COMSEG and/or SPLITF. Subroutine SPLITF will be called if a segment of a feature is to be deleted or it's description is changed. Subroutine COMSEG will be called if features and/or segments from the master and possibly edit files are to be joined into one feature. SYNBEP will construct the pointers to the feature(s) involved so the respective subroutine will know how the feature(s) are to be combined or segmented.
- o If it is not the end of the edit file, the next edit feature is read and the above process is repeated. Otherwise, a call is made to subroutine CLOSUP to copy all unedited features from the master file to the output file, close all the disk files, and exit the task.

4.2 Subroutine SERCL

Subroutine SERCL (Reference Figure No. 4-3) is a standard LIS service routine that performs the following functions.

- o Retrieve an RJE block from the system
- o Exit a task
- o Abort the task



SERCL FUNCTIONAL FLOW

Figure No. 4-3

4.3 Subroutine INITAL

This subroutine is called near the beginning of SYNBEP and is passed to the RJE block which contains the names of the three disk files. Subroutine INITAL (Reference Figure No. 4-4) performs the following functions.

- o Opens all the disk files and places the file identification number and the number of features in each file in the RJE block.
- o Copies the control (zero and twenty) records from the master to the output file.
- o Retrieves the deformation coefficients from the zero records of both input files and converts them to PDP-15 floating point format. These coefficients will later be used to compute the transformation coefficients to require to transform the edit file data.

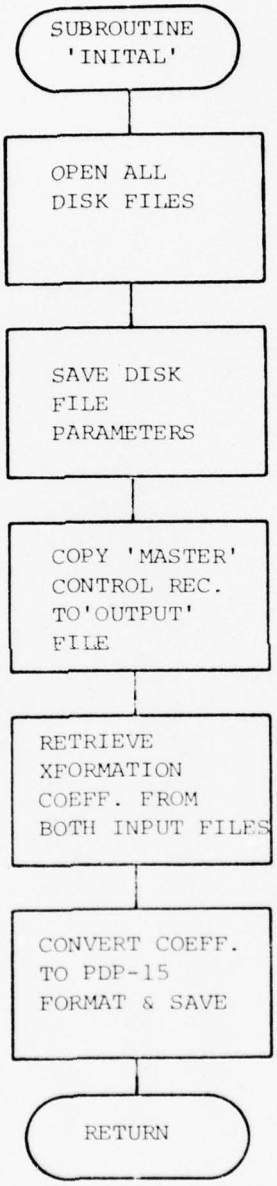
4.4 Subroutine COMCF

Subroutine COMCF (Reference Figure No. 4-5) uses the deformation coefficients to compute the transformation coefficients required to transform the data points in the edit file.

4.5 Subroutine DECOD

Subroutine DECOD is called to interpret the edit functions from the text field of the edit header record. After the function is decoded, a flag(s) is set to identify the requested function. Subroutine DECOD (Reference Figure No. 4-6) operates as described in the following description.

- o The text field is unpacked into a string of ASCII characters without spaces.
- o Starting with the first character, the characters are decoded. The first character of the two character function code denotes the function and the second character is decoded to set the appropriate function flag.

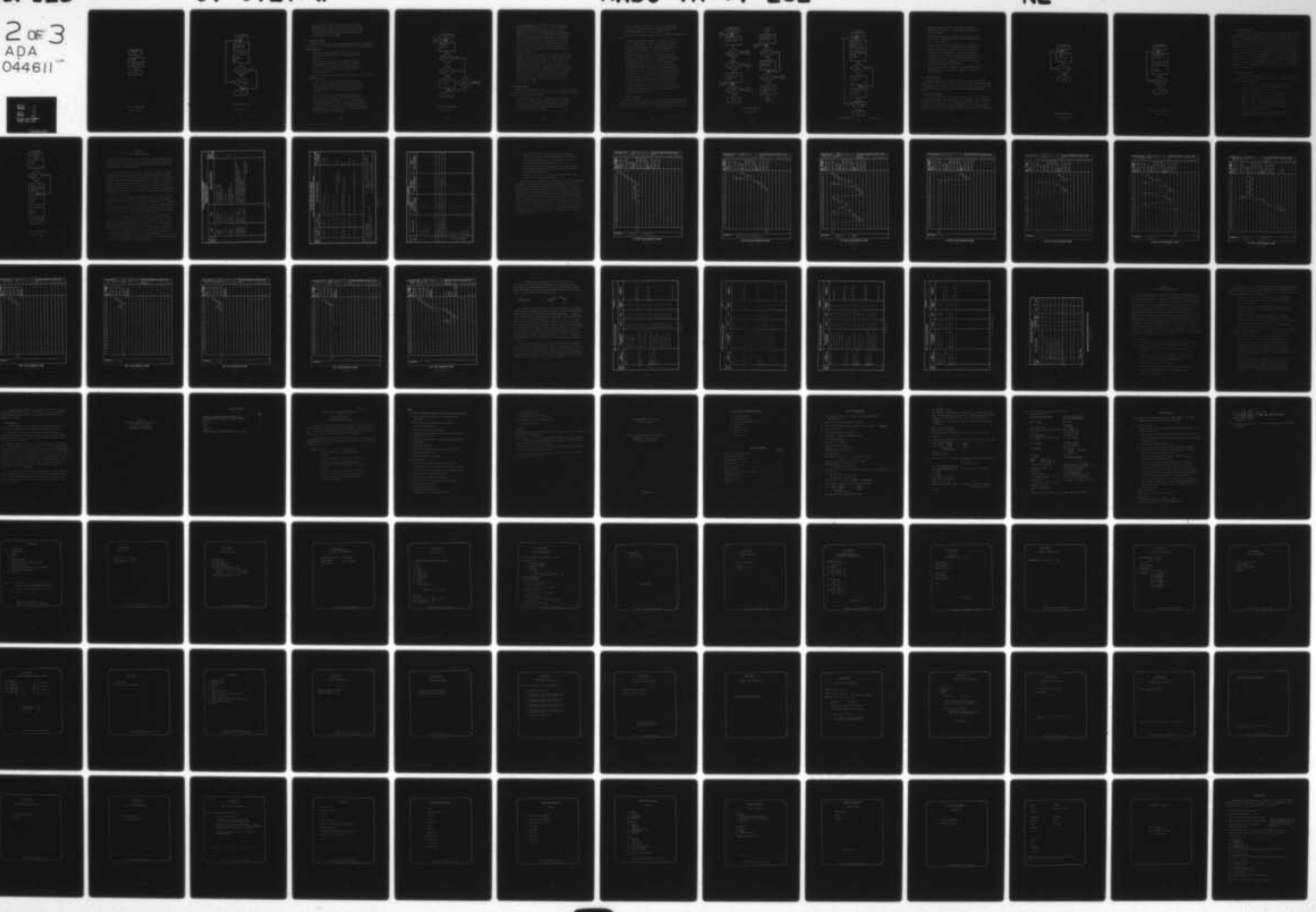


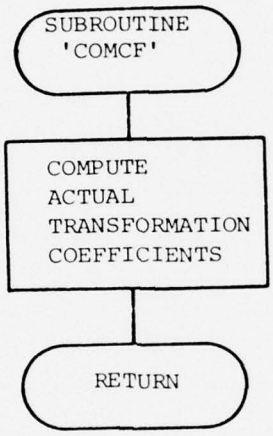
INITAL FUNCTIONAL FLOW

Figure No. 4-4

AD-A044 611 SYNECTICS CORP ROME N Y F/G 8/2
DIGITAL REVISION TECHNIQUES.(U)
AUG 77 T B KOLASSA, A J KREUTZER F30602-76-C-0104
UNCLASSIFIED CT-0727-W RADC-TR-77-262 NL

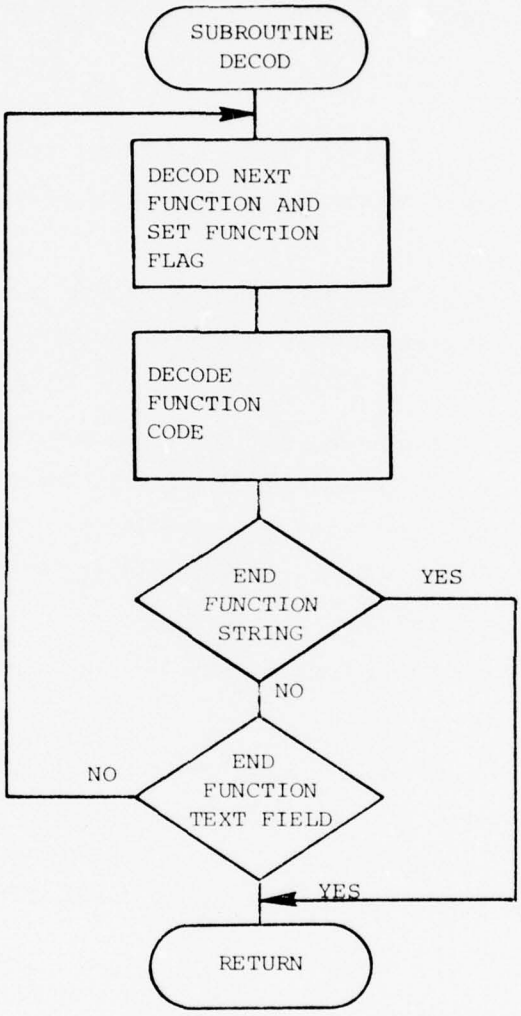
2 OF 3
ADA
044611





COMCF FUNCTIONAL FLOW

Figure No. 4-5



DECOD FUNCTIONAL FLOW

Figure No. 4-6

- After each function code is decoded, a check is made to the next character which should be a punctuation character used to separate fields or end the string. When a period is detected or the end of the text field is reached, subroutine DECOD returns to SYNBEP.

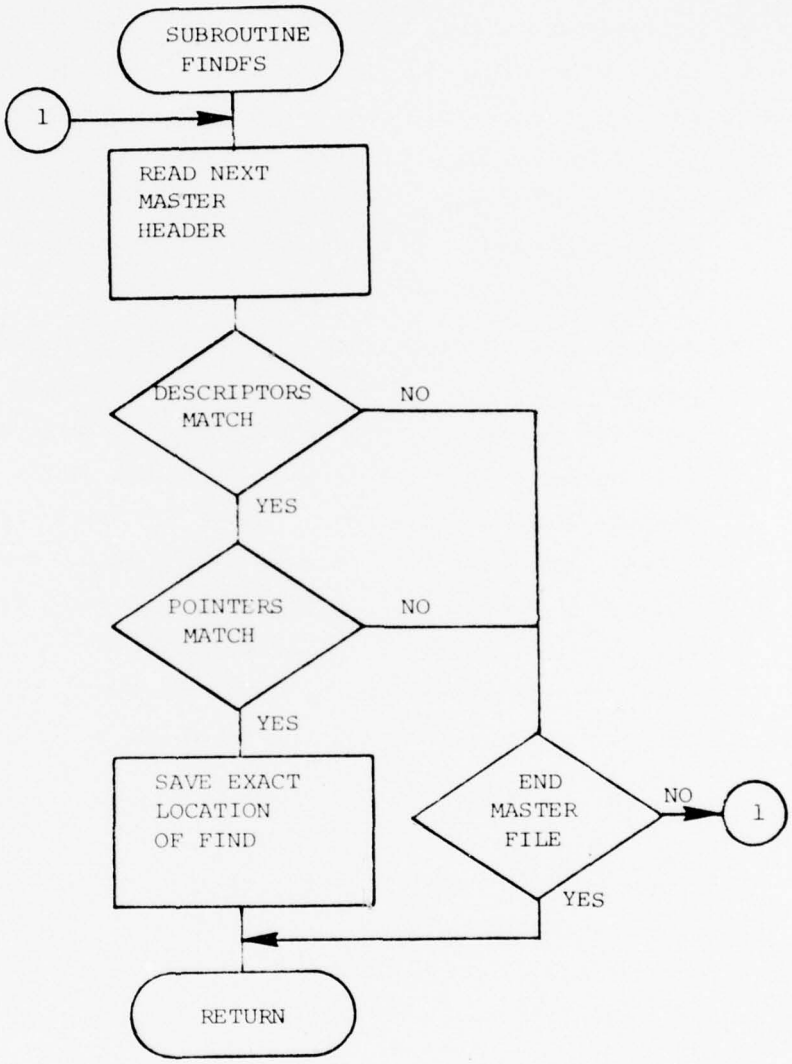
4.6 Subroutine FINDFS

The FINDFS subroutine is called to find a master feature that matches the edit request. It is capable of searching the master file with the following search parameters.

- Search for a feature description match of one, two, or three levels of description (i.e. the class, type and subtype)
- Search a feature X,Y string, that has been accepted by descriptor match, for a match with the edit features first or first and last point. This selective search can be for every point in the master file feature or only the first and last points.

Subroutine FINDFS (Reference Figure No. 4-7) operates as described in the following functions.

- Initially sets its entered parameters to read the first feature's header record and uses the parameters from the calling routine to define the number of description levels to compare and the X,Y point comparison required for the function.
- Then the next header record is read from the master file and is compared to the descriptors defined by the edit header record and the number of levels to compare parameter. If a description match is found, this subroutine will go to the next function. Otherwise it will read the next feature's header unless it is at the end of file which causes subroutine FINDFS to return to calling routine.



FINDFS FUNCTIONAL FLOW

Figure No. 4-7

- The feature header record is tested to see if it contains the minimum/maximum X,Y values. If it does not, then the subroutine will proceed to the next function. If these values exist, a test is done to determine if the edit feature point(s) are within this area. When a feature is determined to be in a completely different area than the edit points, the next master feature will be retrieved unless it is the end of the master file which will cause this subroutine to return to the calling program. If the edit point(s) fall within the area, a complete text will be done as described in the next function.

- Depending on the input parameters, this subroutine will either compare the first and last points of the header record to the point(s) in the edit header record, or it will compare the edit header record points to every point in the master file feature looking for a match. When the requested point(s) are found, the master file feature number, block number, and vector address is passed back to the calling routine for each point (one or two) found. If no match is found, the next header record is retrieved and the above functions are repeated. At the end of the master file, this subroutine will return to the calling routine.

4.7 Subroutine SPLITF

Subroutine SPLITF is capable of dividing a feature into two or three separate features and deleting a segment of the feature if requested. It would be used for the following edit requests.

- Change the descriptions of an internal part of an existing feature. The changed segment would be written as a separate feature and the two segments on either end would be written on the output file as two separate features with the same description as the original master.

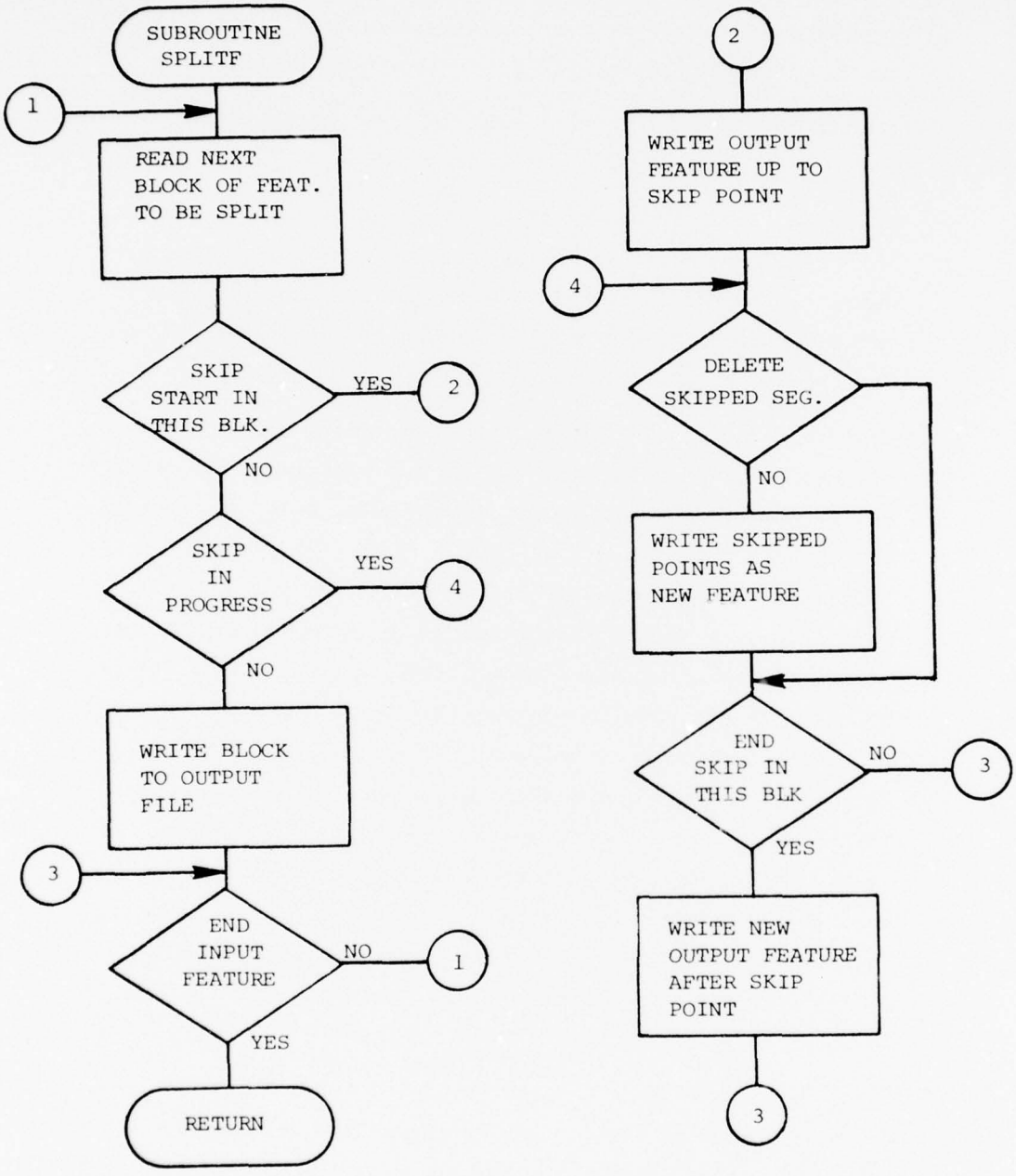
- Delete a segment of a master file feature. The remaining segment(s) would be written out on a separate feature with the same description as the original master feature.

Subroutine SPLITF (Reference Figure No. 4-8) performs the following functions.

- Reads the header record of the master feature that is to be split. Determines if the segment to be deleted or changed starts at the first point. The parameters that were generated by subroutine FINDFS will identify exactly where to start and the end segment to be changed or deleted.
- Reads the next trailer record and tests to see if skipped segment (i.e. The segment that is to be changed or deleted) starts in this block. If not skip segment yet, then writes trailer block on the output file. If the skip starts in this block, writes out the trailer record up to the point where the skip starts then writes the original master header record for this segment. Once a skip is detected as starting; then each block, including the block where the skip started, must be tested to find the end of the skip. While subroutine SPLITF is processing the skipped segment, it will either ignore this data for a delete or write it on the output file as a new feature with the edit header record. All data points after the last skipped point will also be written as a new output feature with the header record associated with the original master feature.

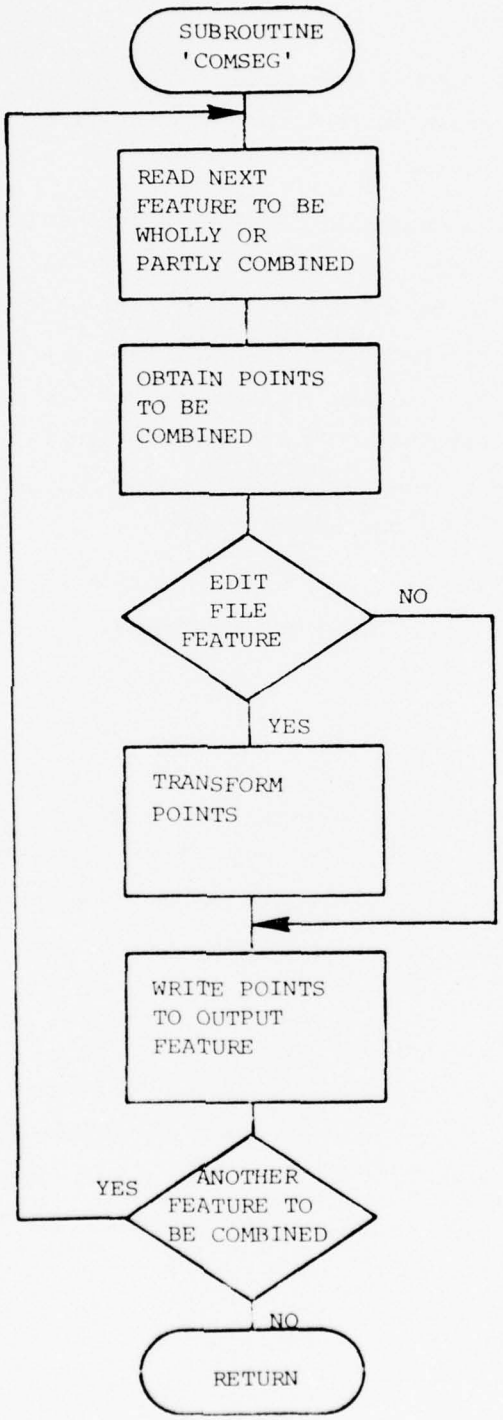
4.8 Subroutine COMSEG

Subroutine COMSEG is capable of combining two or three features and/or segments from the input master file and up to one segment from the edit file. This subroutine (Reference Figure No. 4-9) performs the following functions.



SPLITF FUNCTIONAL FLOW

Figure No. 4-8



COMSEG FUNCTIONAL FLOW Figure No. 4-9

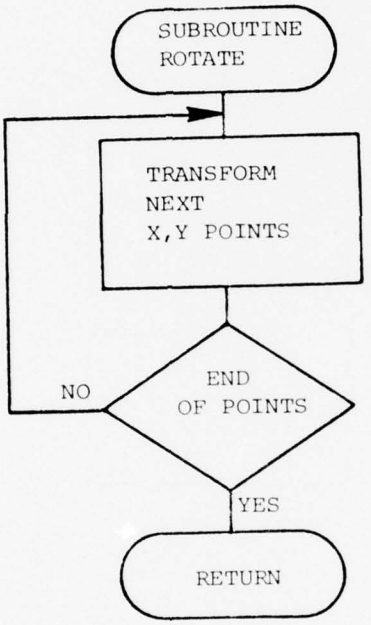
- o Examine the table passed to it by SYNBEP and determine the number of segments to be combined and set up to process the first segment.
- o Reads the first segment and places it in the output buffer. Each time the output buffer is filled, it is written on disk as the output feature.
- o Then it reads the remaining segments and packs the points in the output buffer. As the output buffer is filled, the buffer is written in the output file as the next trailer record of this created feature. Each time a new segment is started, a test is made to determine if the data is from the master or edit file. If it is from the edit file, a control flag is set to transform all the edit points before they are packed into the output buffer.
- o After the last trailer is written, the updated header record associated with an original master feature is written for the new feature.

4.9 Subroutine ROTATE

Subroutine ROTATE (Reference Figure No. 4-10) is passed a table of X,Y points from the edit file and a table containing the transformation coefficients. This subroutine will transform each edit point in the table and return the same tables except that the X,Y point table will contain the transformed data.

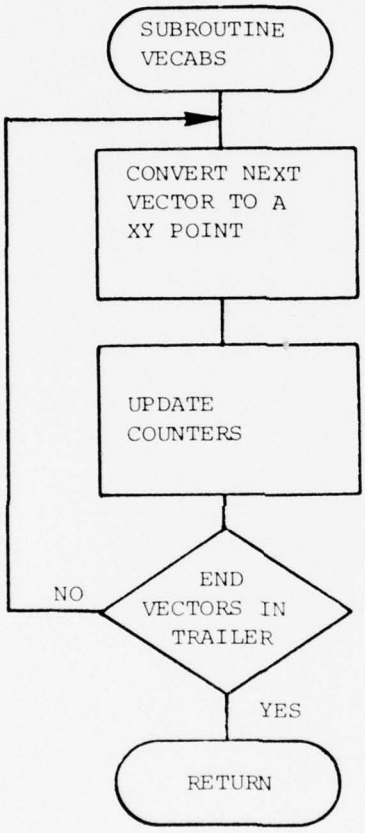
4.10 Subroutine VECABS

Subroutine VECABS (Reference Figure No. 4-11) is passed the input trailer record in standard LIS format. Each vector is converted to a delta X and delta Y and added to the previous X,Y point to compute the next X,Y point. This process is repeated until all vectors are converted. The X,Y points are passed back to the calling routine in a table that was defined in one of the parameters.



ROTATE FUNCTIONAL FLOW

Figure No. 4-10



VECABS FUNCTIONAL FLOW

Figure No. 4-11

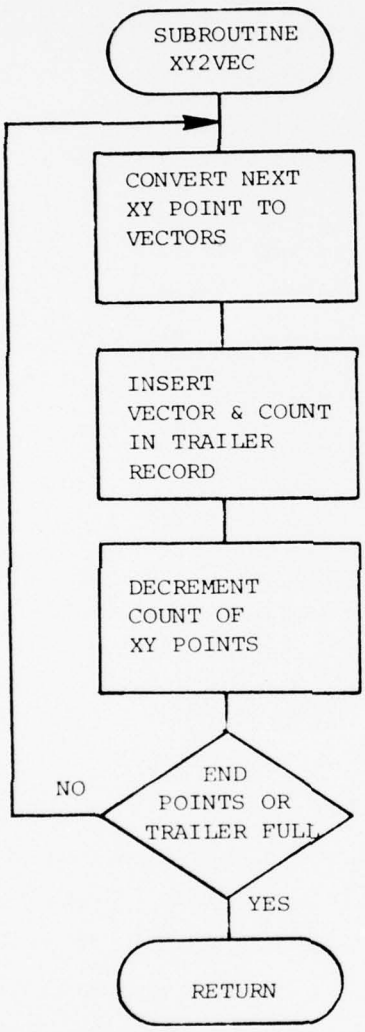
4.11 Subroutine XY2VEC

Subroutine XY2VEC (Reference Figure No. 4-12) is passed, via the calling parameters, a table of X,Y points, a trailer record buffer, the number of X,Y points in table, the last X value, and the last Y value. This subroutine will compute the delta X and delta Y between the last point and the next point. Then the delta X and delta Y will be converted to vector values which will be packed into the next available location(s) of the trailer record. This process is repeated until all points are converted to vectors and packed into the trailer record or the trailer record has been filled. For either case the subroutine returns to the calling program. The calling program can examine the number of points passed to XY2VEC and if it is not zero then it is interpreted to mean that all points were not processed since the trailer record has been filled. The calling routine would write the trailer on disk, clear the buffer area, preset the trailer values, preset pointers, and call XY2VEC to process the reamining points.

4.12 Subroutine CLOSUP

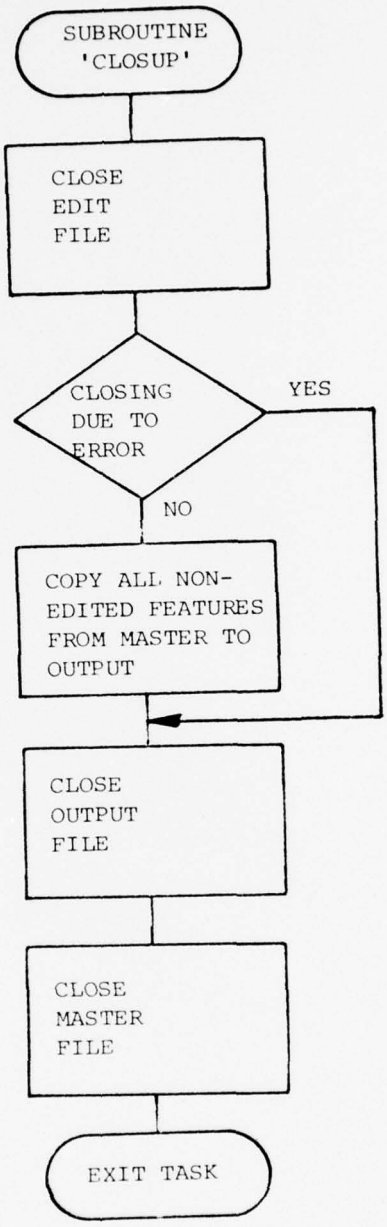
Subroutine CLOSUP (Reference Figure No. 4-13) is called to complete the output file after the last edit has been completed. This subroutine will perform the following functions.

- Close the edit file. If an error has been detected during executing this task, the next function is skipped and all the files are closed and the task is exited.
- Each master file feature is copied to the output file unless the feature has been edited. A test is done before each master feature is read to determine if it had been edited. If the feature was involved with an edit, the feature is skipped and the next feature is tested. This function is repeated until the complete master file has been processed.
- The output and master file is closed, then the task is terminated by a call to the system exit function.



XY2VEC FUNCTIONAL FLOW

Figure No. 4-12



CLOSUP FUNCTIONAL FLOW

Figure No. 4-13

SECTION V

TESTING AND EVALUATION

5.0 Due to the lack of finalization of software programs and execution routines, full and complete testing of the automated digital revision techniques was not possible. However, data collection procedures were conducted, statistics compiled and conclusions made.

5.1 Insofar that the decision was made to eliminate the writing of an MMS to LIS format conversion program solely for the reason of using previously collected data, certain preparatory operations were required. The establishment of a "current" data file was necessary and the creation of a "revision" data file. The current data file was created via the LIS process utilizing a section of the Sears Pond 7 1/2' Quadrangle chart. Revision calls specified were addressed to this section and digitized to create the revision file. These revisions were felt to be representative of normal or average cartographic product revision tasks.

Statistics on speed, number of features, type of feature, file length was collected, via software data collection programs and personal observations. Special statistical data collection forms were generated to assist in analyzing the effectiveness of proposed revision methods. In order to obtain comparative statistical data, similar type revisions were executed with both the on-line LIS Work Station Edit Function and the Data Revision Technique (DRT) Revision Process. The results on this data is reported below.

5.1.1 The current data file and the Revision Data File were created by digitizing the previously selected section of the Sears Pond 7 1/2' Quadrangle chart. For clarity and simplification, vegetation feature data was omitted from the current data file. (See Figure No. 2-1). Feature descriptors were selected from the LIS Feature classification menus. The feature descriptors utilized for this test effort are listed in Figure Nos. 5-1 and 5-2. The number of features by feature class, in each file, length of files and distribution of features by length, is contained in Figure No. 5-3.

5.1.2 In establishing the test criteria for the Digital Revision Techniques Project, certain assumptions were made. These were:

DIGITAL REVISION TECHNIQUES
FEATURE DESCRIPTION
CURRENT DATA FILE

LIS CLASS NO.	CLASS	TYPE	AUXILIARY DESCRIPTORS	FEAT QUAN BY CLASS
1	ROADS	HARD SURF, A.W.	ACCURATE/PUBLIC/2 LANE	12
	ROADS	LIGHT SURF, A.W.	ACCURATE/PUBLIC/2 LANE	
	ROADS	DIRT ROAD	ACCURATE/PUBLIC/1 LANE	
	ROADS	FOOT PATH	APPROXIMATE/PUBLIC	
4	CULTURE	PUBLIC WORKS	DAM/MASONRY	2
6	RELIEF	CONTOUR	APPROXIMATE/INDEX	104
	RELIEF	CONTOUR	APPROXIMATE/INTERMEDIATE	
	RELIEF	DEPRESSION CONT.	APPROXIMATE	
7	DRAINAGE	LAKES & PONDS	OUTLINE/PERRENIAL/DEF./NATURAL/LARGE/NAV/SEARS POND	22
	DRAINAGE	LAKES & PONDS	OUTLINE/PERRENIAL/DEF./NATURAL/SMALL/NON-NAV	
	DRAINAGE	ISLAND SHORELINE	SHORELINE/PERRENIAL/DEF./NATURAL/SMALL	
	DRAINAGE	SPRING	OTHER/OUTLET (POINT FEATURE)	
	DRAINAGE	RIVERS & STREAMS	MARSH OR SWAMP/ABOVE GROUND	
	DRAINAGE	RIVERS & STREAMS	CENTER LINE/PERRENIAL/DEF./ABOVE GROUND/NATURAL/ SMALL/NON-NAV.	

Figure 5-1

DIGITAL REVISION TECHNIQUES
FEATURE DESCRIPTION-REVISION FUNCTION CODES

REV CALL NO.	LIS CL NO. CLASS	TYPE ( ) NO. OF FEAT	AUXILIARY DESCRIPTORS	REV. FUNC. CODE (IN COMMENTS TEXT FIELD)
1.	6-RELIEF	CONTOUR (1)	APPROXIMATE/INDEX	DS:AS:IE.
	6-RELIEF	CONTOUR (3)	APPROXIMATE/INTERMEDIATE	DS:AS:IE.
2.	1-ROADS	LIGHT DY, A.W. (1)	ACCURATE/PUBLIC/2 LANE	CS:AS:IE.
3.	4-CULTURE	PUBLIC WORKS (1)	DAM/MASONRY/THADS DAM	AF.
	7-DRAINAGE	LAKES & PONDS (1)	OUTLINE/PERR./DEF./A.GRND/MAN MADE/LARGE/NAV-YES/ KREUTZER POND	AF:EA.
4.	6-RELIEF	CONTOUR (1)	APPROXIMATE/INTERMEDIATE	AF.
	6-RELIEF	LOCAL ELEV. (1)	SPOT ELEVATION/UNIDENTIFIABLE/ACCURATE/1833	AF.
5.	1-ROADS	LIGHT DY, A.W. (1)	ACCURATE/PUBLIC/2 LANE	DS:AF:IJ.
6.	7-DRAINAGE	RIVERS & STRMS (1)	CENTERLINE/PERR./DEF./A.GRND/NATURAL/SMALL/NAV-NO	AF:DC.

AF = ADD NEW FEATURE
AS = ADD NEW SEGMENT
CS = CHANGE DESCRIPTION, EXISTING SEGMENT
DS = DELETE EXISTING SEGMENT
DC = ADDED STRM, CREATE CONTOUR DEPRESSION
EA = EXTRACT FEATURE/SEGMENTS WITHIN CLOSED FEATURE
IE = JOIN ENDS TO EXISTING FEATURE
IJ = EXTEND FEATURE TO BEGIN/END ON NEW FEATURE

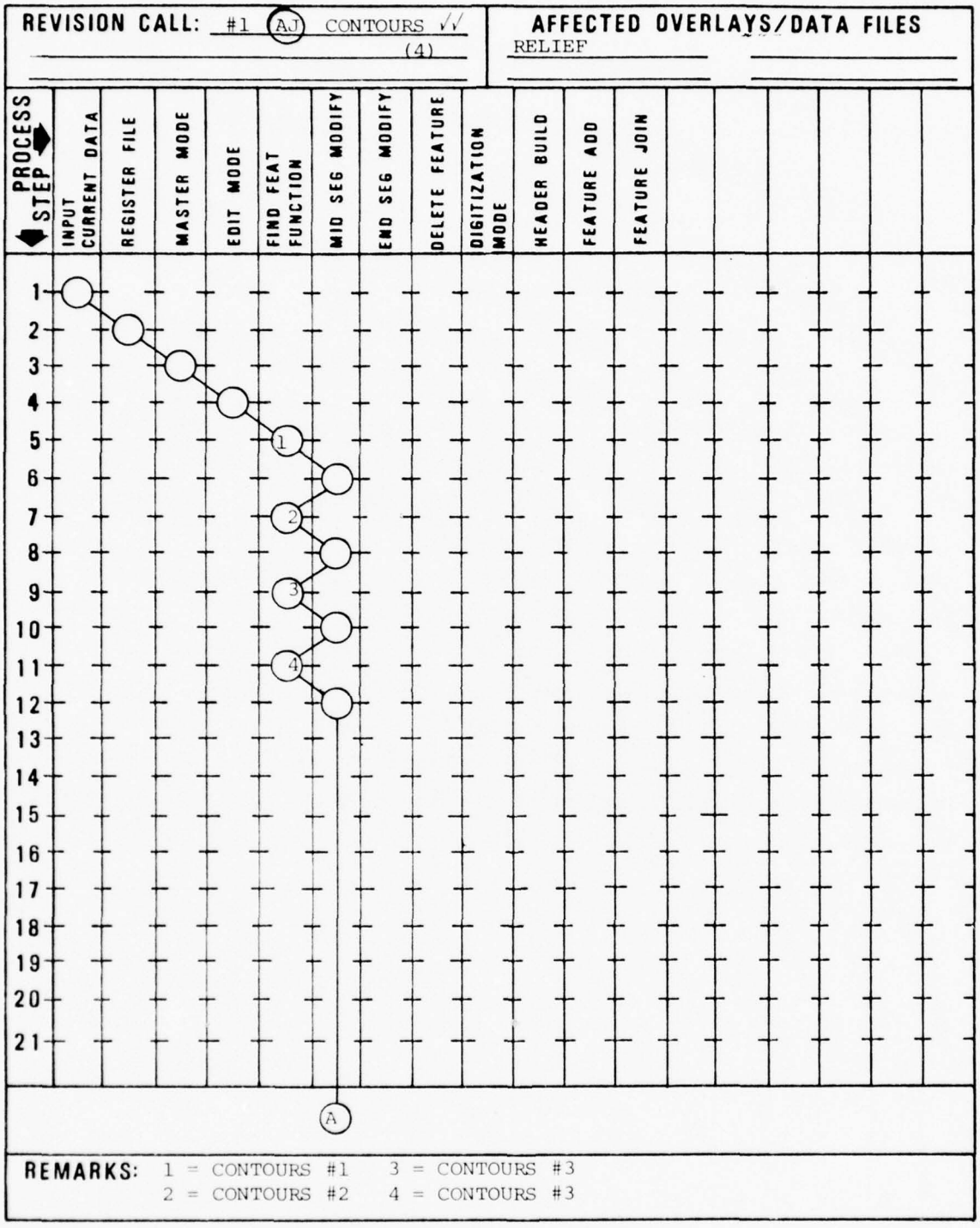
Figure 5-2

DATA FILE CONTENT				
LIS NO.	FEATURE CLASS	CURRENT	REVISION	NEW
		NO. OF FEATURES	NO. OF FEATURES	NO. OF FEATURES
1	ROADS	12	2	
4	CULTURE	2	1	
6	RELIEF	95	6	
7	DRAINAGE	23	2	
	TOTAL	132	11	
	LENGTH OF FILE	426.4365	15.8374	
	AVE. LENGTH FEATURE	3.2304	1.4396	
DISTRIBUTION OF FEATURES BY LENGTH	POINT	1	1	
	0-2	90	7	
	2-4	11	2	
	4-6	11	1	
	6-8	5		
	8-10	2		
	10-12	2		
	12-14	3		
	14-16	1		
	OVER 16	6		

Figure 5-3

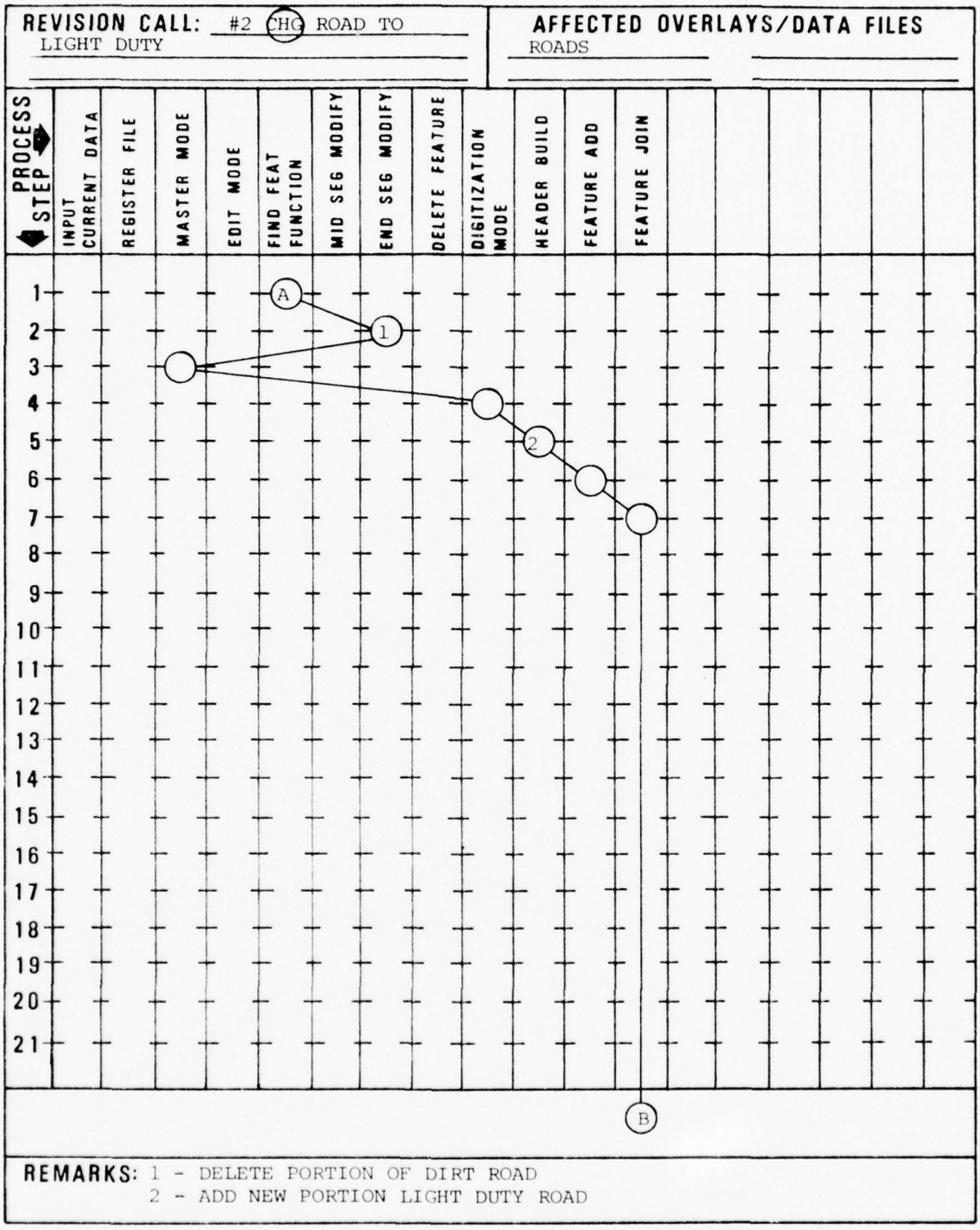
- o Data files for current chart data would be in compatible format for processing on whatever system was to be utilized.
- o Current Data File build time was not an item of concern and would not become a part of test statistics.
- o Revision Data File build time was an item of concern and would be considered as part of the statistics for the exercise of Digital Revision Functions.
- o Production operation personnel would be fully trained in the application of either revision method.

Each revision call specified was evaluated for its overall work process requirement in relation to the system being employed to effect revision. Step Process Flow Charts for each method were established. In as much as edit session and/or revision processes, would be a continuous work effort, these flow charts run concurrently from Revision Call Number 1 thru Revision Call Number 6 eliminating the return to preliminary stages of processing such as "Input". In similar manner termination actions such as "plotting", "output" "symbolization", etc. are shown for last revision call only. Figure No. 5-4 through 5-10 list process steps for the LIS system method of edit/ revision, Figure 5-11 through 5-16 list steps for the DRT method. Utilizing criteria as set forth above, a Test Plan was established for conducting new procedure validation and process comparison. This Test Plan is included in this report as Annex A.



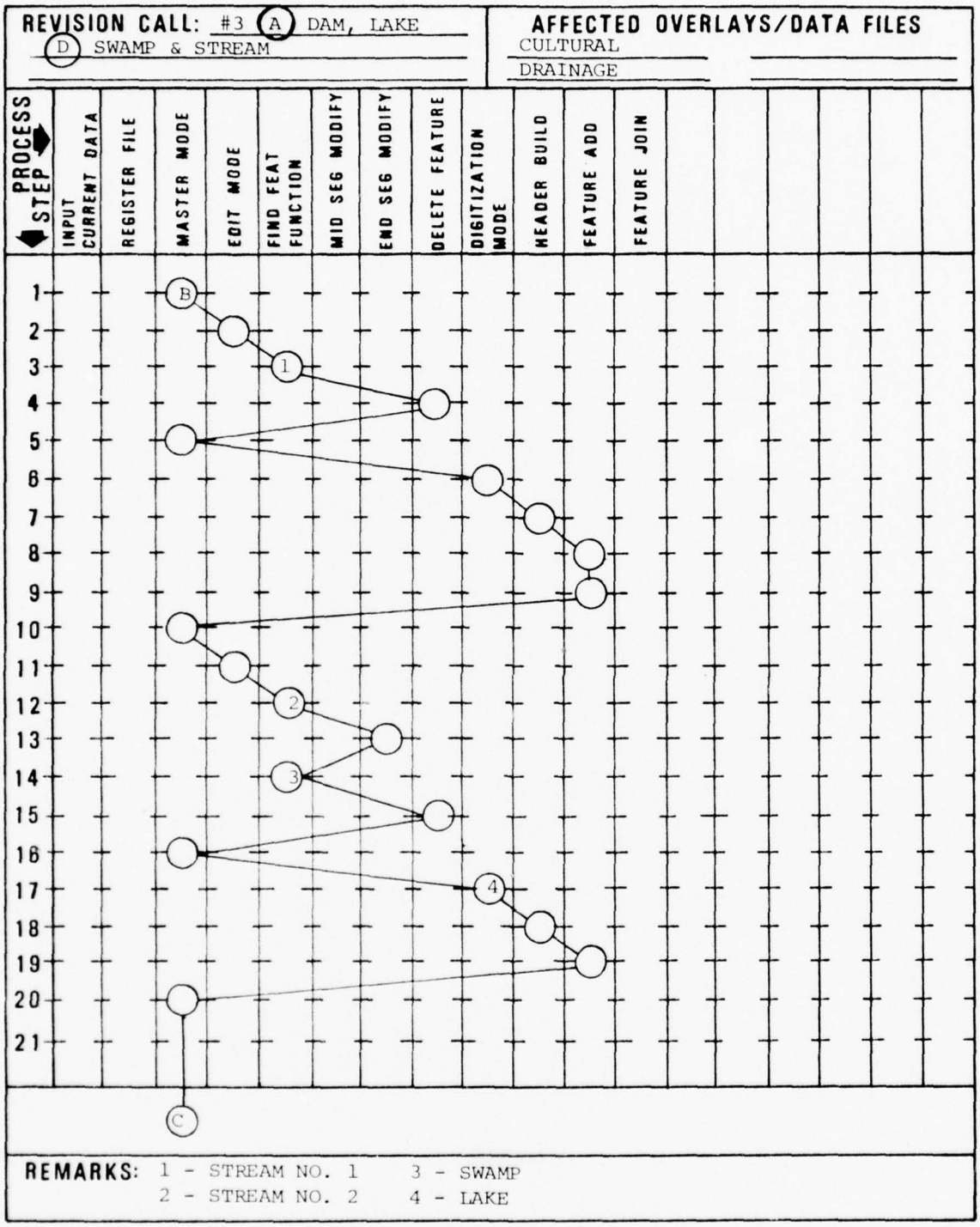
LIS EDIT STEP PROCESS FLOW

Figure No. 5-4



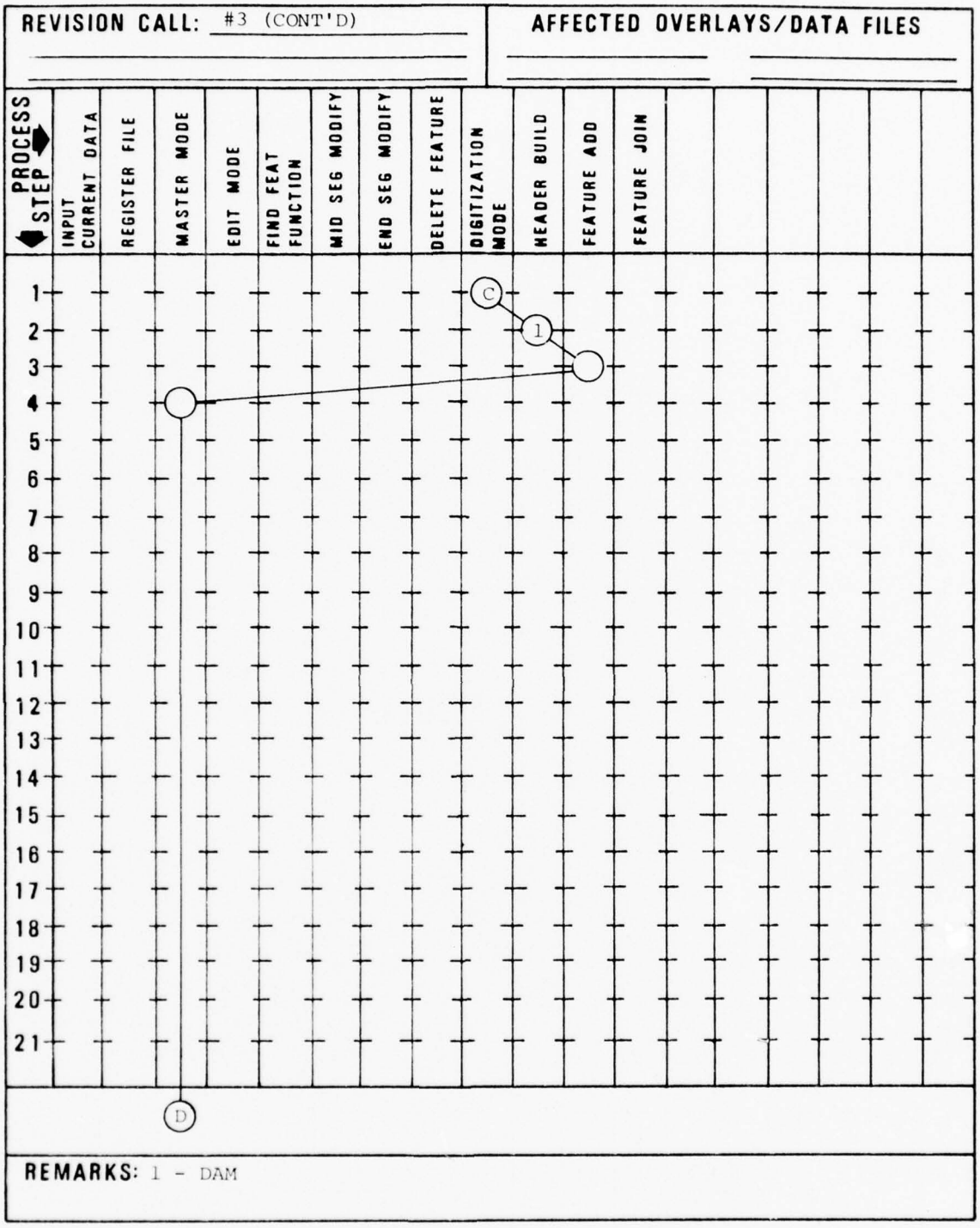
LIS EDIT STEP PROCESS FLOW

Figure No. 5-5



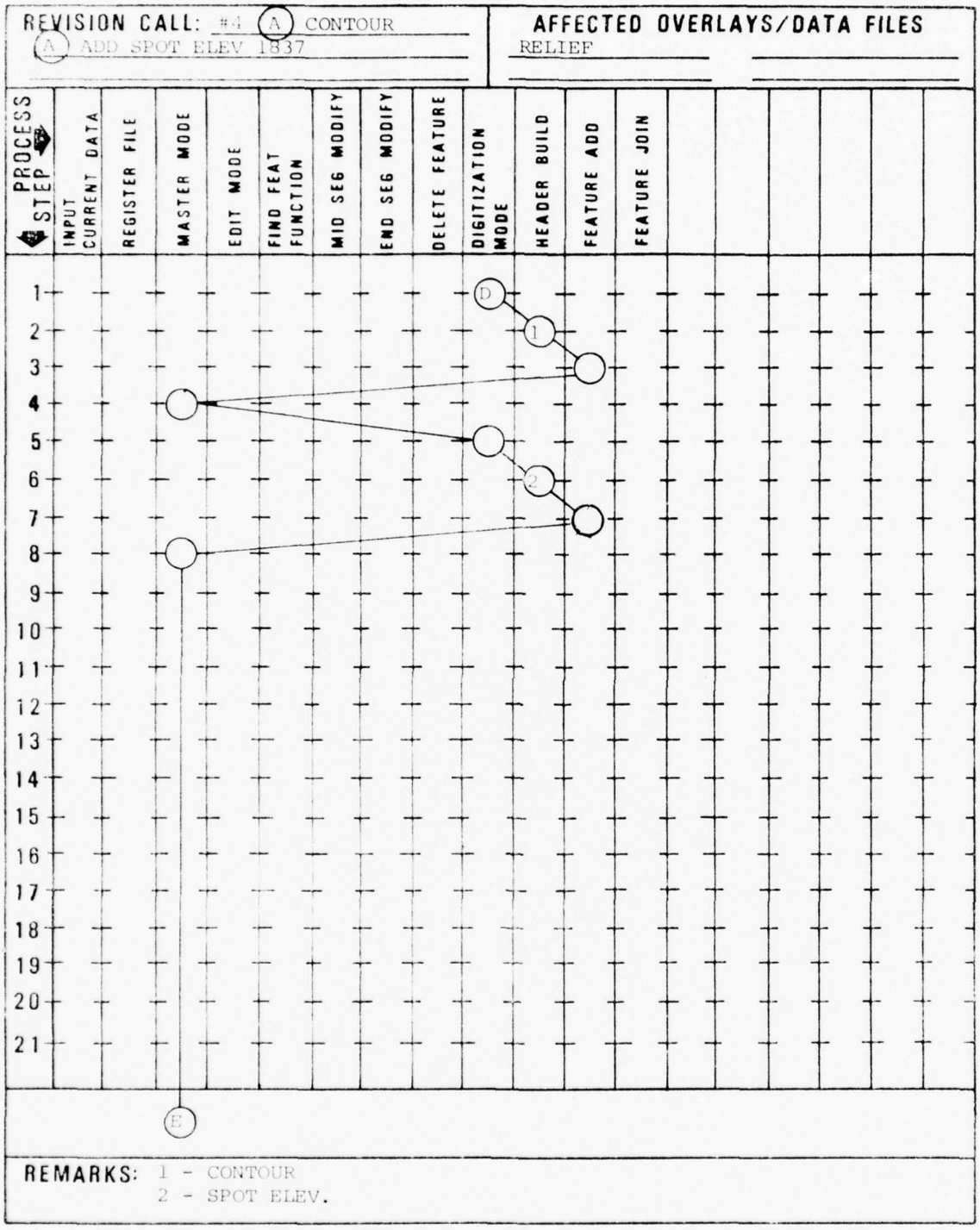
LIS EDIT STEP PROCESS FLOW

Figure No. 5-6



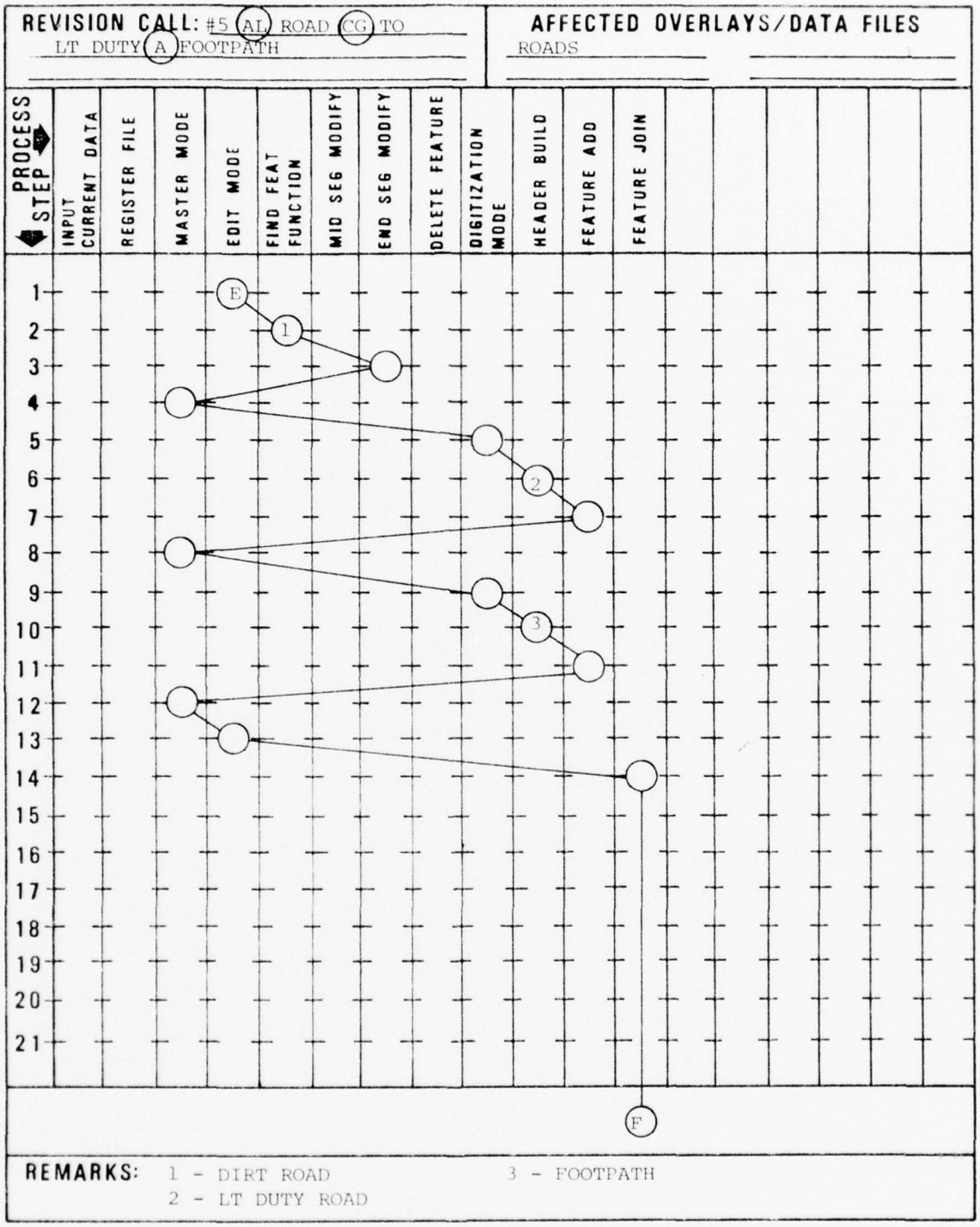
LIS EDIT STEP PROCESS FLOW

Figure No. 5-7



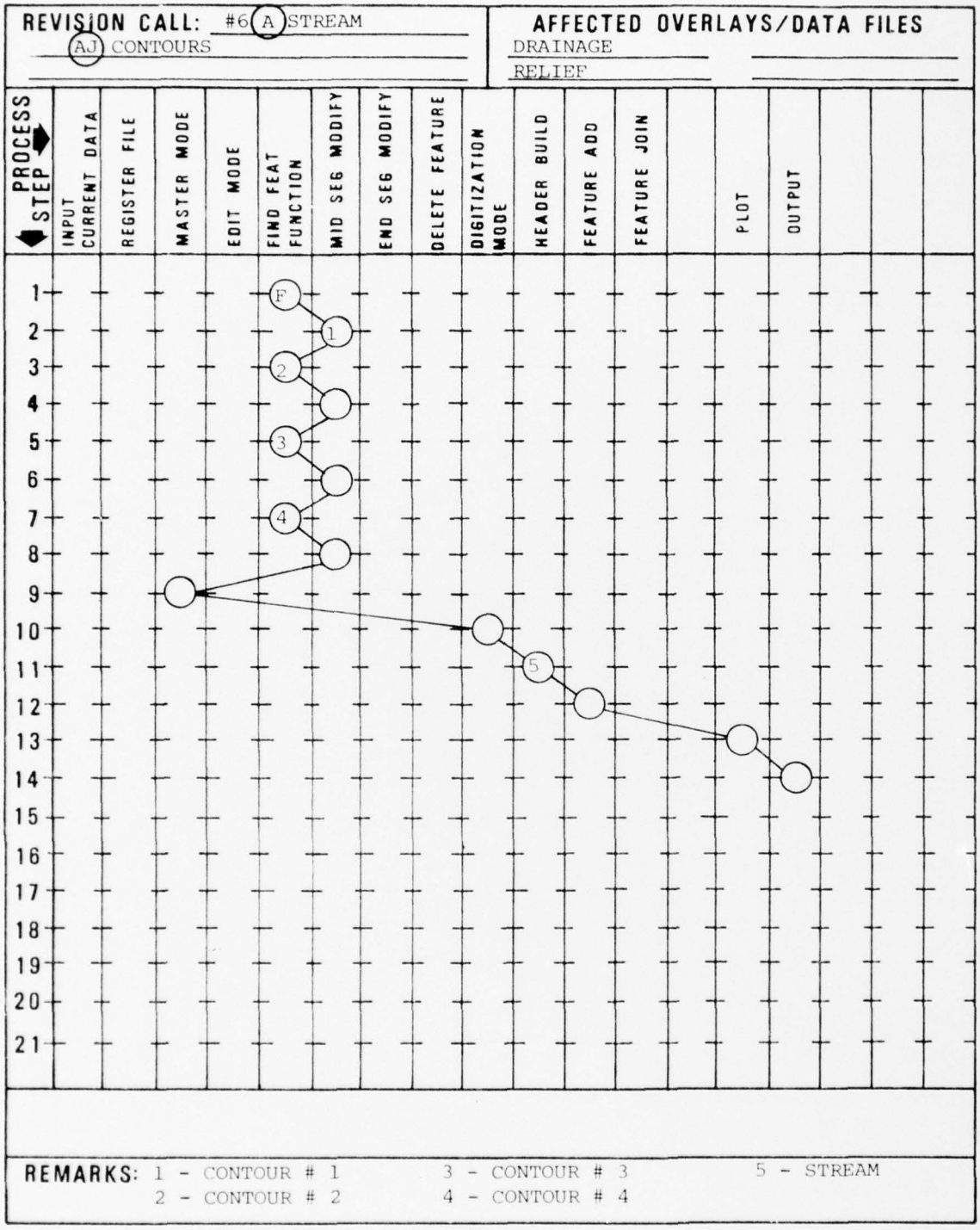
LIS EDIT STEP PROCESS FLOW

Figure No. 5-8



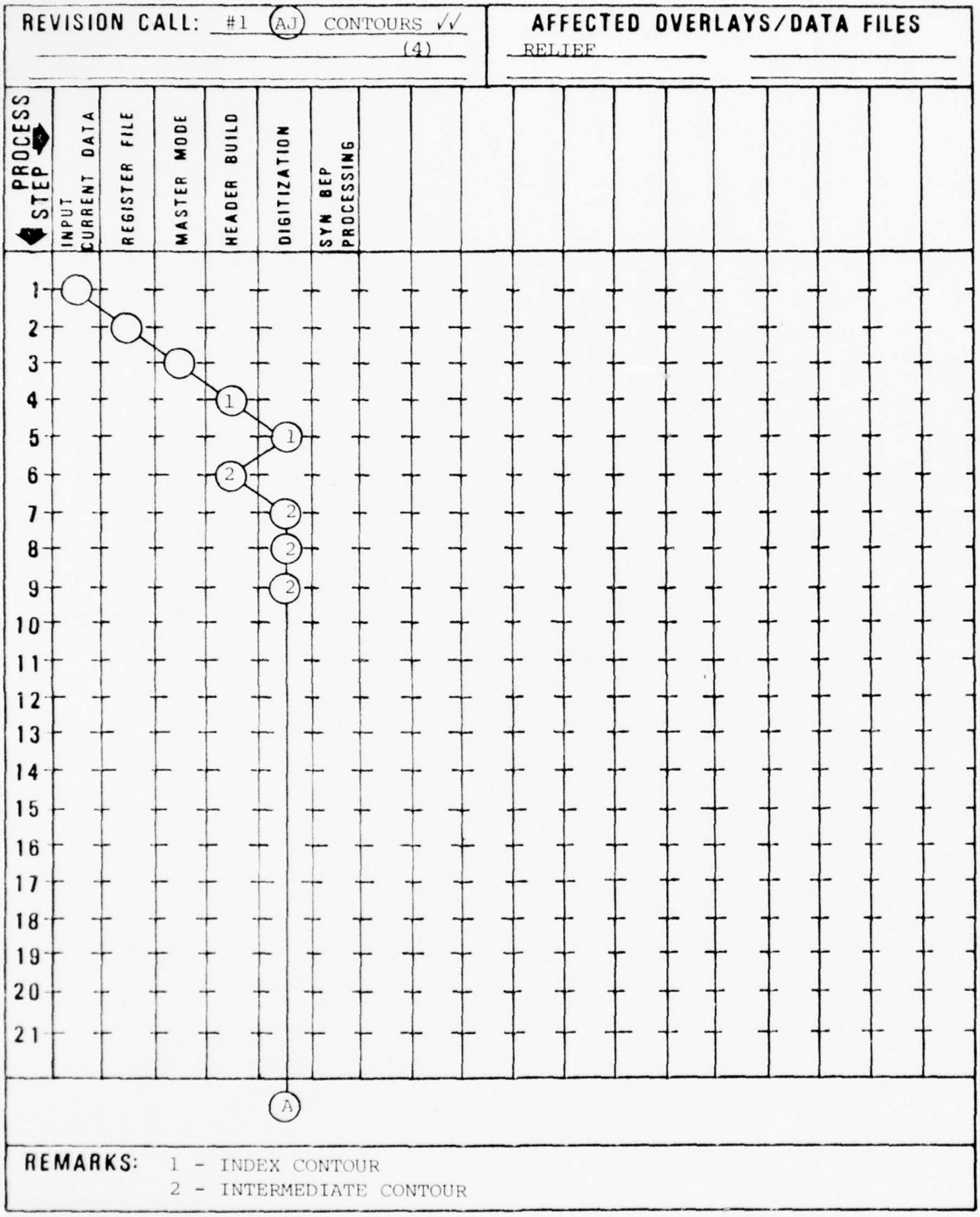
LIS EDIT STEP PROCESS FLOW

Figure No. 5-9



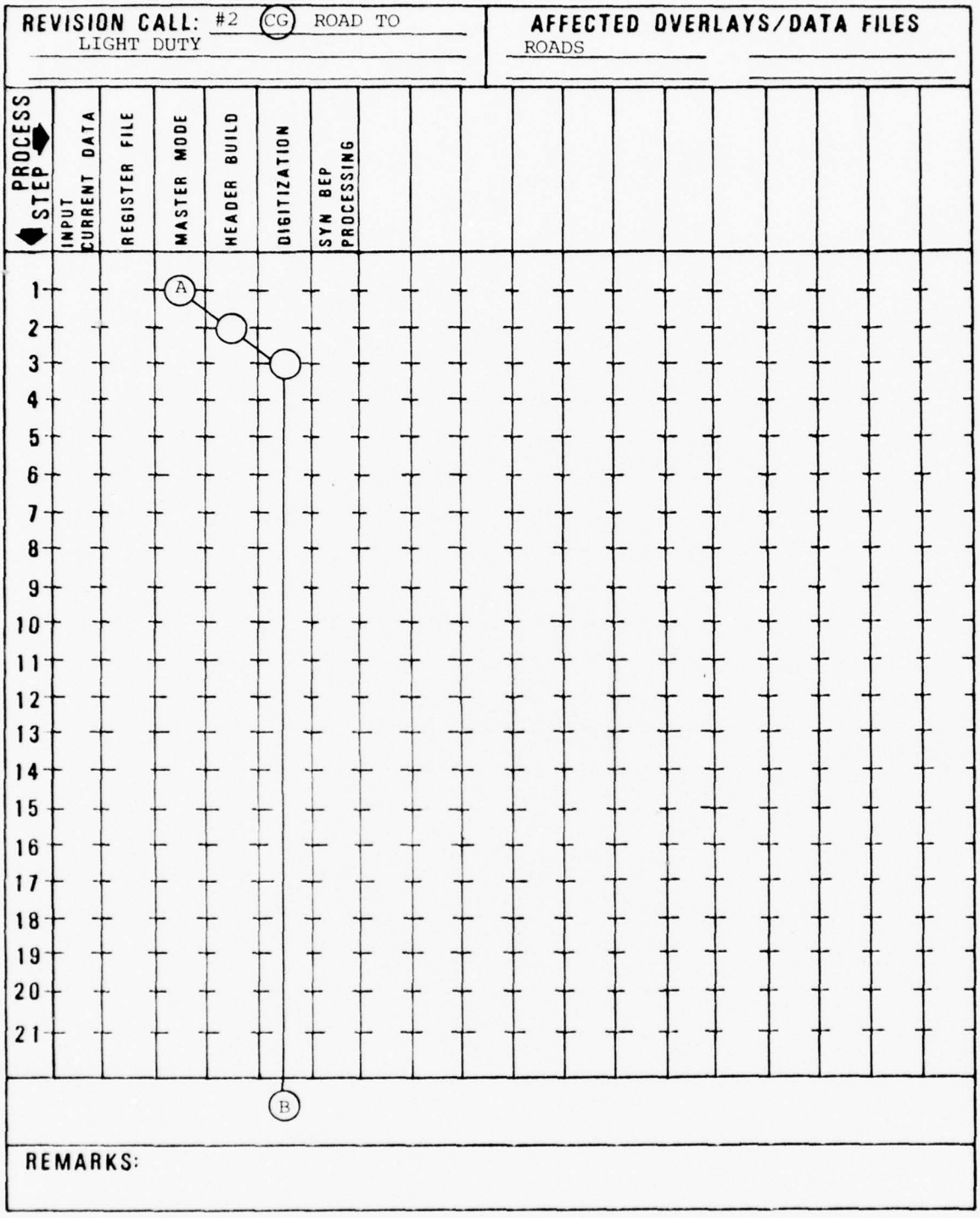
LIS EDIT STEP PROCESS FLOW

Figure No. 5-10



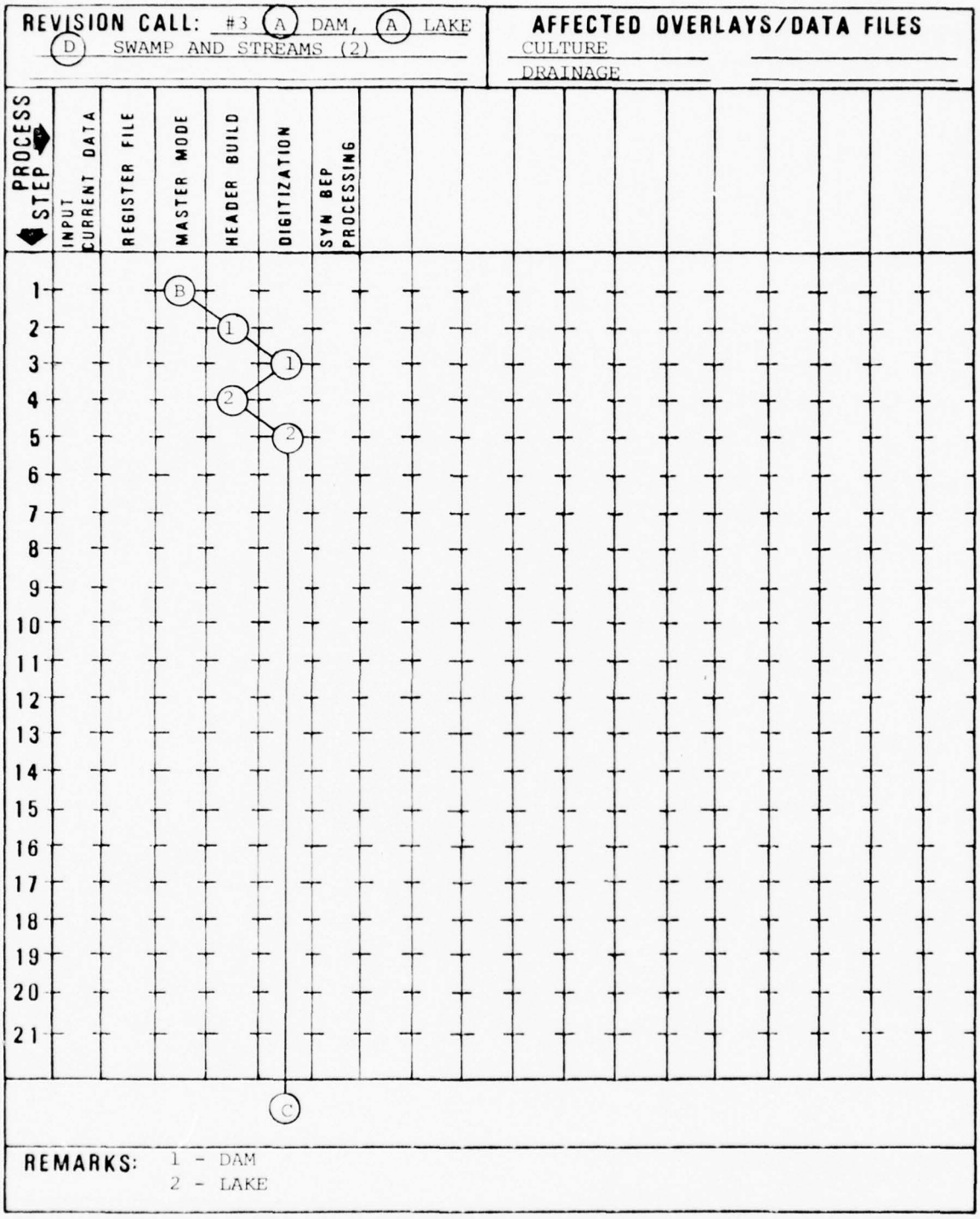
DRT STEP PROCESS FLOW

Figure No. 5-11



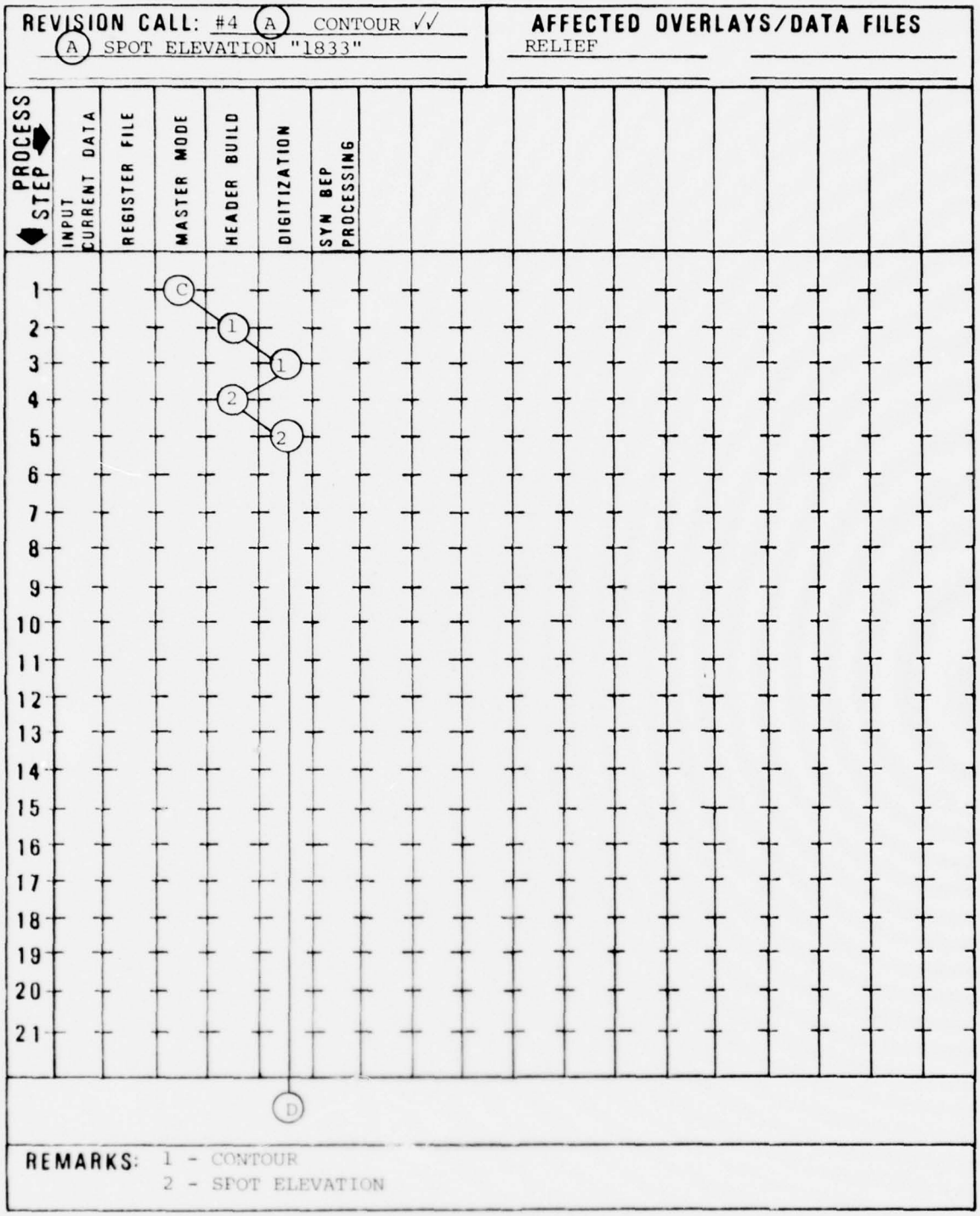
DRT STEP PROCESS FLOW

Figure No. 5-12



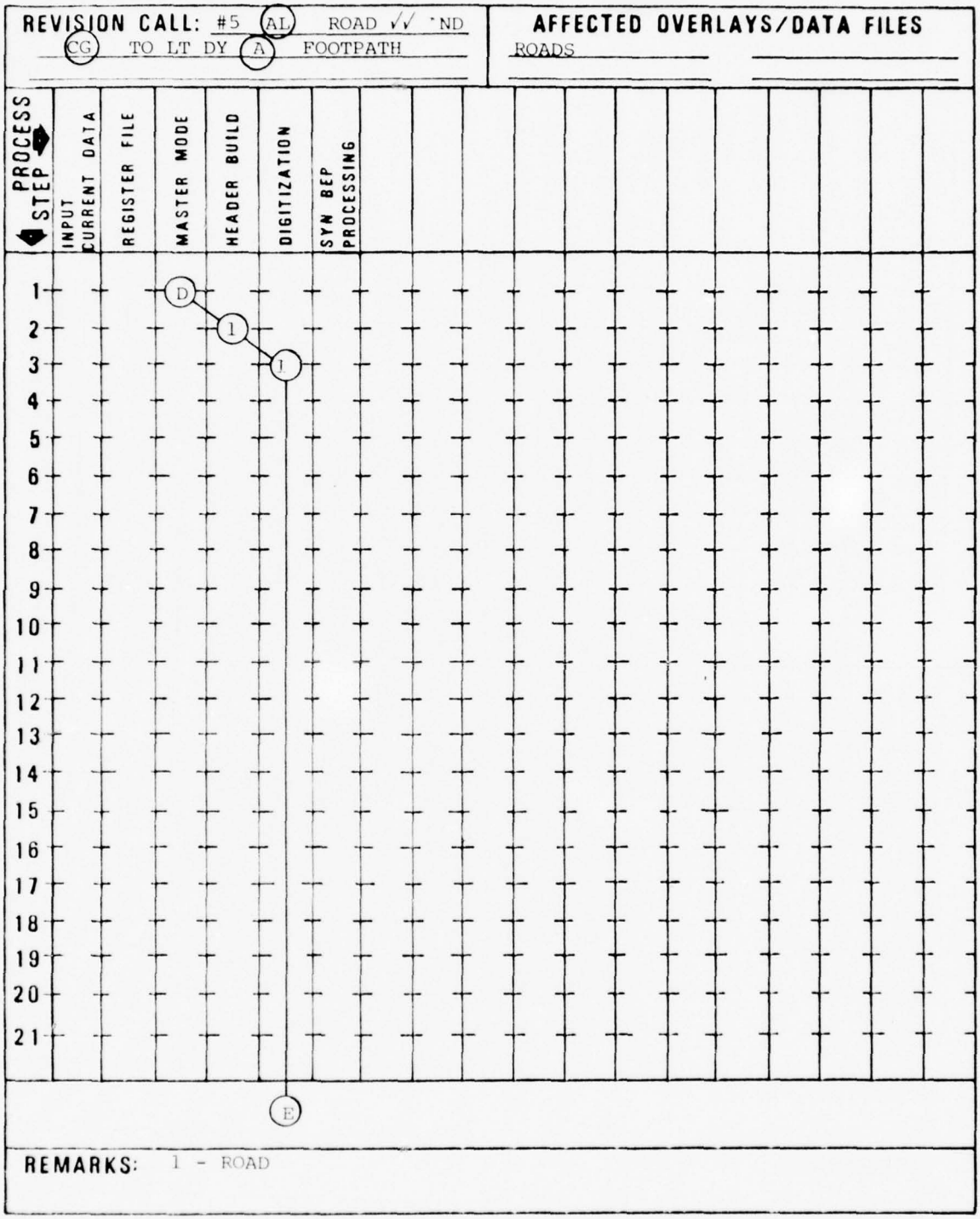
DRT STEP PROCESS FLOW

Figure No. 5-13



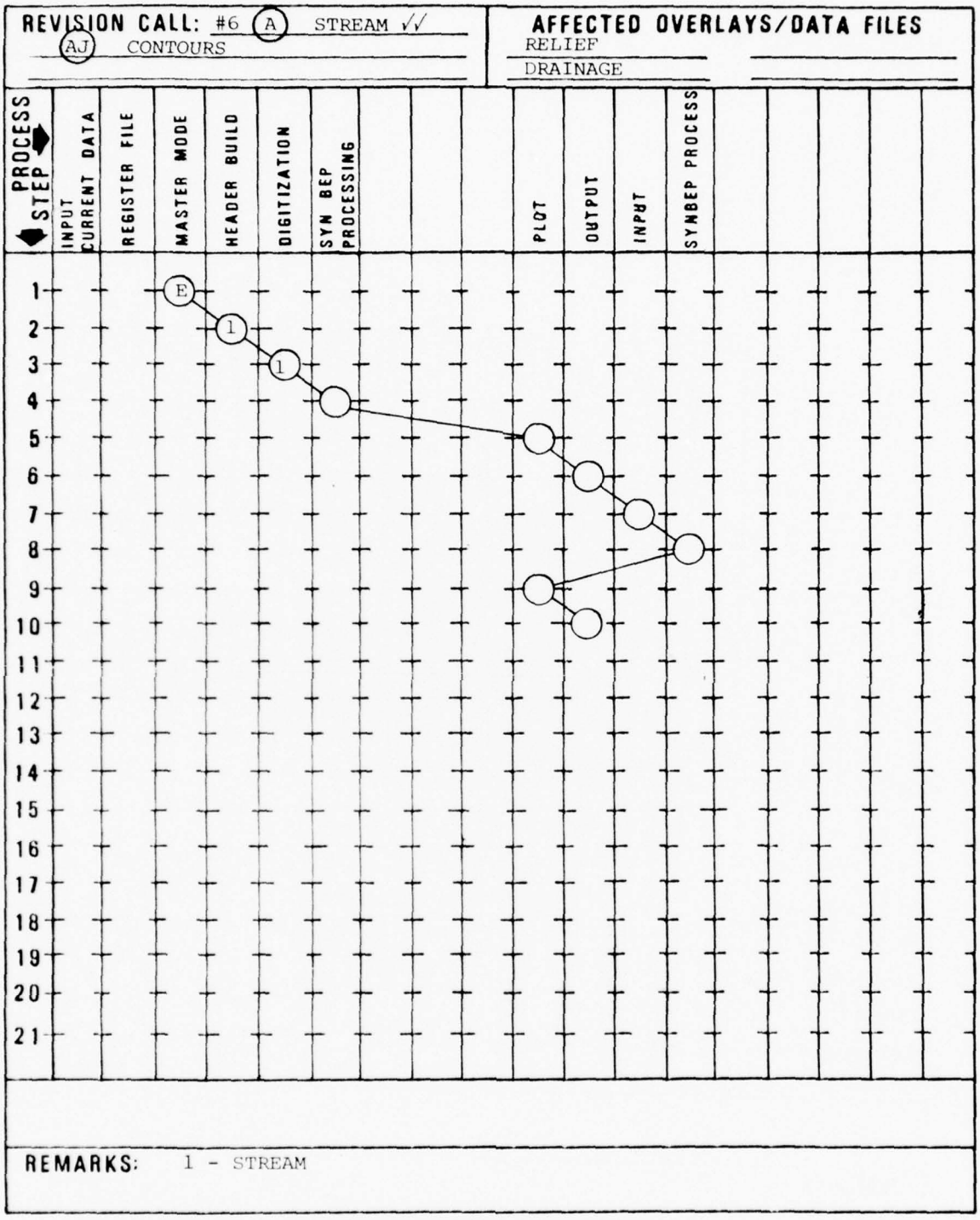
DRT STEP PROCESS FLOW

Figure No. 5-14



DRT STEP PROCESS FLOW

Figure No. 5-15



DRT STEP PROCESS FLOW

Figure No. 5-16

5.1.3 Comparison of the step process flow charts (Figure 5-4 to 5-16) and the functional processes between the LIS edit process and the Digital Revision Techniques Batch Edit process reveals a substantial reduction in the number of individual actions necessary to effect a required revision. Specific examples of this reduction are:

	No. of Steps	
Revision Call	LIS Edit	DRT
3	23	4
2	6	2

This reduction in revision process actions was reflected in the overall times required to accomplish the required revisions. Using the LIS Edit method a total of 44 minutes was required for the actual edit process. (Figure No. 5-17). When the Digital Revision Techniques Batch Edit Data Entry method was used, a total of 29 minutes was required. (Figure No. 5-18). In comparing the two methods on a call for call basis, (Figure No. 5-19) it is indicated that the greatest benefit to be realized by employing the DRT Batch Edit method is in situations where multiple features of various classifications are affected. The addition of the SYNBEP post processing time has little overall detrimental effect to the revision time. With further software refinement, this post processing time could be reduced appreciably. The overall improvement of 30% reduction in revision times for the processes exercised is considered significant.

Data entry and revision actions when employing the LIS as the hardware means for effecting changes is somewhat complex. To complete the necessary actions numerous button manipulations are required and involves three separate devices, the PDS-1 keyboard, the special function keyboard and the digitizing cursor. Combining keyboard/cursor function and elimination of separate actions where possible, would enhance the overall revision operation.

DRT TIME DATA COLLECTION					METHOD: LIS RUN # 6	
REV CALL NO.	CALL DESCRIPTION	EDIT/REVISION FUNCTION	START	STOP	ELAPSED TIME	COMMENTS
1	(AJ) CONTOUR (4)	MODIFY SEGMENT 1	20:30	20:32	:02	
		MODIFY SEGMENT 2	20:32	20:34	:02	
		MODIFY SEGMENT 3	20:35	20:37	:02	
		MODIFY SEGMENT 4	20:37	20:39	:02	
						TOTAL:CALL #1=:08
2	(CG) ROAD TO LT DY	DELETE END SEGMENT	20:41	20:42	:01	
		BUILD HEADER	20:42	20:44	:02	
		DIGITIZE NEW SEGMENT	20:44	20:45	:01	
						TOTAL:CALL #2=:04
3	(A) DAM, LAKE	BUILD HEADER (DAM)	20:45	20:46	:01	
	(D) SWAMP, STREAM	DIGITIZE DAME	20:46	20:47	:01	
		BUILD HEADER (LAKE)	20:47	20:49	:02	
		DIGITIZE LAKE	20:49	20:51	:02	
		DELETE STREAMS	20:51	20:52	:01	
		BUILD HEADER	20:52	20:54	:02	
		DIGITIZE STREAM SEG	20:54	20:56	:02	
		DELETE SWAMP	20:56	20:57	:01	
						TOTAL:CALL #3=:12

Figure 5-17

DRT TIME DATA COLLECTION					METHOD: LIS RUN # 6	
REV CALL NO.	CALL DESCRIPTION	EDIT/REVISION FUNCTION	START	STOP	ELAPSED TIME	COMMENTS
4	(A) CONTOUR	BUILD HEADER (CONTOUR)	20:57	20:59	:02	
	(A) SPOT ELEV. 1833	DIGITIZE CONTOUR	20:59	21:00	:01	
		BUILD HEADER (ELEV)	21:00	21:02	:02	
		DIGITIZE ELEV.	21:02	21:03	:01	
						TOTAL:CALL #4=:06
5	(A) ROAD AND (A) TO IT BY (EXTEND FOOT-PATH)	DELETE END SEGMENT	21:03	21:05	:02	
		BUILD HEADER (ROAD)	21:05	21:07	:02	
		DIGITIZE RD SEGMENT	21:07	21:08	:01	
		MODIFY END SEGMENT	21:08	21:09	:01	
						TOTAL:CALL #5=:06
6	(A) STREAM (A) CONTOURS	BUILD HEADER (STREAM)	21:09	21:11	:02	
		DIGITIZE STREAM	21:11	21:12	:01	
		MID SEGMENT MOD # 1	21:12	21:14	:02	
		MID SEGMENT MOD # 2	21:14	21:15	:01	
		MID SEGMENT MOD # 3	21:15	21:16	:01	
		MID SEGMENT MOD # 4	21:16	21:17	:01	
						TOTAL:CALL #6=:08

Figure 5-17 (Continued)

DRT TIME DATA COLLECTION					METHOD: DRT RUN # 4	
REV CALL NO.	CALL DESCRIPTION	EDIT/REVISION FUNCTION	START	STOP	ELAPSED TIME	COMMENTS
1	(AJ) CONTOUR (4)	HEADER BUILD (INDEX)	13:28	13:30	:02	
		DIGITIZE SEGMENT	13:34	13:35	:01	WORK BREAK :04
		HEADER BUILD (INTER)	13:35	13:37	:02	
		DIGITIZE SEGMENT # 1	13:37	13:38	:01	
		DIGITIZE SEGMENT # 2	13:38	13:39	:01	
						TOTAL:CALL #1=:08
2	(CG) ROAD TO LT DY	HEADER BUILD	13:40	13:42	:02	
		DIGITIZE SEGMENT	13:43	13:44	:01	
						TOTAL:CALL #2=:03
3	(A) DAM, LAKE	HEADER BUILD (DAM)	13:45	13:46	:01	
	(D) SWAMP, STREAM	DIGITIZE DAM	13:46	13:47	:01	
		HEADER BUILD (LAKE)	13:47	13:49	:02	
		DIGITIZE LAKE	13:49	13:51	:02	
						TOTAL:CALL #3=:06
4	(A) CONTOUR	HEADER BUILD (CONTOUR)	13:51	13:53	:02	
	(A) SPOT ELEV 1833	DIGITIZE CONTOUR	13:53	13:54	:01	
		HEADER BUILD (SPOT ELE)	13:55	13:57	:02	
		DIGITIZE SPOT ELEV	13:57	13:58	:01	
						TOTAL:CALL #4=:06

Figure 5-18

DRT TIME DATA COLLECTION					METHOD: DRT RUN # 4	
REV CALL NO.	CALL DESCRIPTION	EDIT/REVISION FUNCTION	START	STOP	ELAPSED TIME	COMMENTS
5	(AL) ROAD AND	HEADER BUILD (ROAD)	14:00	14:02	:02	
	(CG) TO LT DY (EXTEND FOOT-PATH)	DIGITIZE ROAD	14:02	14:03	:01	TOTAL:CALL #5=:03
6	(A) STREAM AND	HEADER BUILD (STREAM)	14:04	14:06	:02	
	(AJ) CONTOURS (4)	DIGITIZE STREAM	14:06	14:07	:01	TOTAL:CALL #6=:03

Figure 5-18 (Continued)

REVISION ENTRY PROCEDURES					
REV CALL NO	CALL DESCRIPTION	ELAPSED TIME		CHG	% CHG
		LIS	DRT		
1	ADJUST CONTOURS (4) AS INDICATED	:08	:08	0	0
2	CHANGE ROAD TO LIGHT DUTY	:04	:03	-:01	25
3	ADD DAM, LAKE AND DELETE SWAMP AND STREAMS	:12	:06	-:06	50
4	ADD CONTOUR AS INDICATED. ADD SPOT ELEVATION 1833	:06	:06	0	0
5	ALIGN ROAD AND CHANGE TO LIGHT DUTY, EXTEND FOOTPATH	:06	:03	-:03	50
6	ADD STREAM AND ADJUST CONTOURS (4)	:08	:03	-:05	64
T		:44	:29	-:15	34
POST PROCESSING (SYNBEP)		N/A	:02	N/A	N/A
TOTAL TIMES		:44	:31	-:13	30

REVISION METHOD COMPARATIVE TIME DATA

Figure 5-19

SECTION VI

CONCLUSIONS AND RECOMMENDATIONS

6.0 Semi-automated revisions techniques as explored during the process of this project, are well within the capabilities of present 'state-of-the-art' software and hardware technology. Some limitations do exist however, in certain phases of raster scan input; raster-lineal, lineal-raster conversion; feature data transformation; and system hardware intrinsic peculiarities. As presently envisioned, there is no all-encompassing revision method applicable to the variety of equipments presently in use in the chart production centers. The Batch Edit method designed as a result of this project is considered the most promising method for addressing the digital revision techniques process. Continued pursuit of improved digital revision techniques and further development of the batch edit method are imperative to the advancement of chart product maintenance. Technique development should not only be addressed to those equipments and systems in use in production centers, but consideration should also be given to the incorporation of recent development technology, such as voice recognition, semi-automatic line tracking, interactive handling of raster scanned feature symbology, and microform plotting techniques.

6.1 Conclusions

o The Batch Edit Program is a viable means to effect digital revisions for chart products. Advantages of the Batch Edit Program include:

- The master file is never transformed thereby reducing feature distortion.
- Less time is required to create an edit file then to edit a master (e.g. on multiple station systems, initial registration of files at start of work shift is time consuming)
- Data entry procedures are streamlined.
- Overall edit/revision process time is substantially reduced.
- Any revision source data (Photo, scaled drawings, chart products) can be employed.

o The adaptability of the software technique for effecting chart revision is highly feasible. Changes for specific systems would be required however. In as much as the batch edit program software was developed on the LIS, changes such as the following, would be required:

- All disk data accesses are via the LIS system routine DMSERV. These calls would have to be changed to a compatible DMSERV type routine developed.
- Most of the routines include FORTRAN bit statements. These statements may have to be modified to duplicate the results on another computer.
- Data file names are passed to the routines via a call to a subroutine "SERCL". This routine would have to be changed to get the filename from an input device (e.g. display, TTY, etc.)
- Subroutine XY2VEC and VECABS are written in assembly language and would have to be rewritten.

o The Lineal Input System (LIS) is not the optimum system for implementing the batch editing capability.

- The LIS has only three disk data files, where each file is to be an input (read only) or output (write only) file.
- In batch editing, the edit file must be transformed before it can be run against the master file. In the LIS it is transformed as it is read and routines must keep track of when the data requires transformation. The program would be simplified if the complete edit file was transformed at the start of the program.
- When a feature is edited the feature is written on an output file and is not available to the program ,if another edit affects that feature. For example, if part of a contour is changed then a lake is to be added that would encompass another part of that contour. Once the contour is changed,

it would not be available for the changes required for the lake being added. The only alternative, on the LIS, is to examine all edits and determine if a feature will be affected by more than one edit before any actual changes are made to the master file. This alternative greatly reduces the speed and efficiency of the batch edit program.

- The LIS does not provide sufficient core for a batch task. The core available for a batch task is 9K words, most other systems allow tasks to use at least 32K words of core. The test batch edit software used all 9K of core, utilizing an overlay structure. Additional code would require changing the overlay structure or breaking subroutines into smaller subroutines.

o Present raster process technology contains some deficiences detrimental to digital revision techniques where mergency of raster and lineal data is required.

- Processing time of basic functions for changing lineal cartographic features to raster form requires too much time and reduces the cost effectiveness of a high speed raster plotter.
- Lineal to raster conversion currently results in incorrect overlap (lack of masking) at feature intersections.
- The raster resolution change subfunction of the format conversion programs possess inflexibilities due to the capability being developed for application to specific devices.
- Raster input process for area fill in may contain discrepancies in the case of tangency occurrence between feature and scan line and where a closed feature meets a nautical chart border.

o Integration and implementation at Production Centers of a completely developed batch edit method digital revision process should pose no problem. Software programs could be tailored to be compatible with equipments now resident at the centers.

6.2 Recommendations

o Further development of the batch edit revision method should be conducted utilizing hardware systems other than the Lineal Input System.

o Development of revision processes should be concentrated on those revisions where multiple features are affected. Time and cost-effectiveness statistics for single feature changes are not necessarily improved through the use of a batch edit method.

o Emphasis should be placed on the complete development of a batch edit method solely for lineal systems as an initial phase. This development would seek to standardize in so far as possible, software programs for applicability to various hardware systems in operation at production centers. Specific software packages could then be devised for individual systems. Where this could not be feasibily conducted at the RADC ECF due to the non-availability of operational systems, consideration should be made of final development "on-site" at production centers. Once the lineal methods of batch edit revision is fully developed then further consideration should be made for merging this method with raster processing systems.

o Future considerations for chart revision processes should include other recent development projects, such as voice recognition, interactive handling of raster scanned feature symbology, and microform plotting techniques combined to configure a range of chart revision subsystems tailored to a variety of system user needs.

ANNEX A

TEST PLAN & PROCEDURES FOR VALIDATION AND COMPARISON TESTING

DIGITAL REVISION TECHNIQUES
CONTRACT NO. F30602-76-C-0104

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Objective	1
Scope	1
Tasks	2
Procedures	3
SPECIAL OPERATING INSTRUCTIONS LIS/PDP-15 GRADICON	4

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TEST PLAN AND PROCEDURES FOR VALIDATION AND *COMPARISON TESTING OF* DIGITAL REVISION TECHNIQUES

This plan is to set forth guidance for the operational feasibility testing of the software procedures devised and generated as a result of this project. Comparison testing between the newly devised software and established Lineal Input System Editing Procedures will also be conducted.

OBJECTIVE: The objective of these tests is to exercise and evaluate data manipulation procedures specifically devised as part of this project and obtain comparison data for analysis.

SCOPE: The scope of this test plan is as follows:

- o Assess the capabilities of digital revision *techniques*.
- o Collect data relative to operational feasibility.
- o Collect data relative to comparative merits of *established editing procedures and digital revision* techniques.
- o Establish criteria for modification recommendations.
- o Assess the capabilities of processes *experienced* in order to identify dificiencies relative to production requirements.

TASKS

1. Establish comparative reference data utilizing Xynetics Plotter.

   - o Plot current data file prior to initiating editing procedures.

   Utilizing present LIS editing/revision procedures,

   - o Input current data file.
   - o Record current data file statistics.
   - o Exercise LIS Edit function for deletion and modification of features as required.
   - o Exercise LIS Digitization function to add new revised data as required.
   - o Plot edited data file.
   - o Record time required for effecting each revision call.
   - o Output edited data file.
   - o Record edit data file statistics.

2. Provide DRT data.

   Using the LIS, digitize the required revision data.

   - o Annotate feature header with correction function symbol.
   - o Collect data as to time required to effect digitization.
   - o Plot and verify revision feature data.
   - o Record revision feature file statistics.

   Using the LIS, exercise the DRT Correction Program.

   - o Input Current Data File.
   - o Input Revision Data File.
   - o Execute DRT Correction Function.
   - o Record time data for correction function.

- o Plot New Data File.
- o Output New Data File.
- o Record New Data File statistics.

3. Compare plots for accuracy, completeness.

   - o Record observations.

Procedures

1. Operating procedures for the LIS for use in exercising the revision methods are contained in Attachment #1.

2. Time data will be collected utilizing data collection forms, Attachment No. 2. Comparative time data analysis will be recorded on the Revision Method Comparative Time Data Form, Attachment No. 3.

3. Work flow process for effecting revisions via the LIS Editing/Digitizing function is contained in Attachment No. 4.

4. Work flow process for effecting revisions via the DRT Correction Function is contained in Attachment No. 5.

SPECIAL OPERATING INSTRUCTIONS

LIS/PDP-15/GRADICON

FOR USE IN CONJUNCTION WITH DATA FILE BUILD

CONTRACT NO. F30602-76-C-0104

DIGITAL REVISIONS TECHNIQUES

Attachment # 1

LIS OPERATIONAL PROCEDURE OVERVIEW

1. Initialize PDP-15
2. Initialize Disk Pack
3. Initialize IMLAC/Work Station
4. Create File
5. Register
6. Digitize/Edit
7. Plot
8. Output to Tape

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PDP-15 INITIALIZATION

1. Turn on CPU power (if off) (Usually only turned off Friday's)
   ALL ADDRESS SW - Ø
2. Turn on TTY (Check ECC Terminal: on LOCAL)
3. Turn on Line Printer (Main switch below cabinet in front) Put ON LINE.
4. Turn on DEC Writer
5. Load Disk Pack #12 on Disk Drive #1
   Set switches to ENABLE, READ/WRITE, START
6. Turn Disk Drive #Ø OFF
   -COLD BOOT -L&JS SYSTEM-
7. Set DEC TAPE DRIVE numbers
   LH Drive to #1 RH Drive to #2
   (Thumb wheel used for setting)
8. Mount DEC TAPES
   Tapes marked: LJS RSX-1 2/17/77 (Date could change)
   Reels No. 1, 2, 3, 4
   (Tapes located on lowest tray, left hand side)
   Mount DEC TAPE Reel 1 on DEC Drive 1
   DEC TAPE Reel 2 on DEC Drive 2
   After reel 1 and 2 are read in (following remainder of this sequence--see item 11) Load
   DEC TAPE Reel 3 on DEC Drive 1
   DEC TAPE Reel 4 on DEC Drive 2
   After mounting set switches to REMOTE and WRITE LOCK
9. Load paper tape (RSX Restore) into Paper Tape Reader
10. Push [STOP] [RESET] and [READ IN]
    (Simultaneously)
    TTY Responds: RSX RESTORE DECTAPE TO DISK

11. Push [CONT] (Continue)

DEC tapes will start Reading In. When DT 1 is finished, remove (turn drive off) and mount DT #3 on Drive #1. (TTY will respond DT NOT READY. Ignore and proceed to mount tapes). When DT #3 is mounted, push [REM] (Remote) and DT 3 will read in. Use same procedure for DT #4 on DR #2.

After tapes have read in:

TTY responds: RSX RESTORE

(Replace DEC Tapes in proper containers and replace on Tape rack).

-WARM BOOT-

12. Load small blue (WARM BOOT) paper tape in paper tape reader (insure tape is under hold down plate)

Push: [STOP] [RESET] and [READ IN]

(Simultaneously)

Tape will read in

TTY Responds: MCR>

13 In response to TTY; (underlined portions are to be typed in by operator)

␣ = Space

↵ = Carriage Return

MCR> ETI␣HH:MM:SS␣MM/DD/YY↵

e.g. ETI␣2Ø:15:ØØ␣Ø2/24/77↵ (Use 24 hour time, Ø for blanks)

MCR> SAV↵

MCR> GLF↵

LIS SYSTEM IS INITIALIZED

DATE: Ø2/24/77 2Ø:15:2Ø

ENTER SHIFT CODE 2↵

ENTER TIME OF LIBRARY UPDATE - HH:MM 06:15 (10 hours or so ahead of initialization time)

PACK ID?

14. Disk Pack Activation (Keep Pack Drive Ø OFF)

In response to TTY For:

Disk Pack Activation Only	Disk Pack Initialization (If using scratch pack)
PACK ID? Ø12↵	PACK ID? ↵
	MCR> INP ↵
DRIVE NUMBER ? 1↵	PACK ID?Ø12↵
PKI COMPLETE. ØØXX BLOCKS AVAILABLE	DRIVE NUMBER? 1↵
PACK ID?↵	SAV GLFS DATA? N↵
MCR> CAN␣LJSMES↵	RES TRACK? 51,4↵
MCR> (OPTION - CHECK LIST OF DISK FILES)	RES TRACK? 52,Ø↵
15. MCR> RIF␣1↵	RES TRACK? 52,16↵
	RES TRACK? 53,12↵
MCR> AWS␣Ø↵	RES TRACK? ↵
	PKI COMPLETE. XXXXX BLOCKS AVAILABLE
MCR> JID↵	PACK ID? ↵
PASSWORD	MCR>REA␣6␣MT␣NONE↵
⊠⊠⊠⊠⊠⊠ ØØØØØØ↵ (Does not print out)	
PRINT,EDIT,NEW LINE? N↵	(Load Mag Tape "TRA DPO→MTØ" before proceeding - see additional instructions on load M.T.)
PCN ØØØ99↵ OR ØØØØ1 ↵	Check Printer (ON LINE)
STATUS A↵	MCR>TRA␣MTØ,DP1,R↵
JOB NAME? THAD↵	(Mag tape reads in, wait until file is in and Line Printer prints out msg) (approx 2 min)
DATE DD/MM/YY↵ (Type in Current Date)	TTY PRINTS: TRA COMPLETE (GO TO 15)
(eg 24/03/77)	
TTY Prints out Summary of above	
CORRECT? (Y OR N) Y↵	
PRINT,EDIT,NEW LINE? ↵	
MCR>	

End of PDP-15/Disk Activation - Go to IMLAC/GRADICON Work Station.

AT WORK STATION

NOTE: TAPE MAP TO DIGITIZING TABLE IN LEFT LOWER QUADRANT. LEFT LOWER CORNER OF MAP ABOVE AND TO RIGHT OF SCRIBE MARK.

16. Turn on Instronics

a. Select button 2 under the lable INC select on the Instronics, Ltd., PDS-1 interface box.

b. Select button XY under the label AXIS Select on the interface box.

c. Push button "POINT" under the label record mode; this button should remain depressed.

d. Set Toggle SW labeled "scale" to 1:1.

e. Flip the switch at the lower left corner of the PDS-1 interface box to the ON position. This is the power switch for the box. The light next to the switch should be ON.

f. Depress the large square button labeled "POWER" at the upper left of the box, causing it to glow.

g. Lightly press the button "INC" under the label record mode so that neither that button nor the point button is physically depressed. Move the cursor to the lower left of the table--crosshair on scribed point. Depress buttons X RESET and Y RESET. (Ø-Ø reading on interface display). Then depress the ERROR RESET button. Now depress pushbutton 2 on the Digitizer cursor.

h. Select the resolution for the job to be done via the thumbwheel switch labeled "RESOLUTION". The small window shows the selected resolution in microns divided by 10 (i.e., 2 corresponds to a 20-micron resolution).

17. Turn on IMLAC PDS-1D.
Power switch located on lower back panel

18. BOOT IMLAC
Load Pink Paper Tape - Put reader in: RUN
Set Address Switches @ 40 (ØØØ ØØØ ØØØ 1ØØ ØØØ)

Depress: STOP START (Tape Reads In).

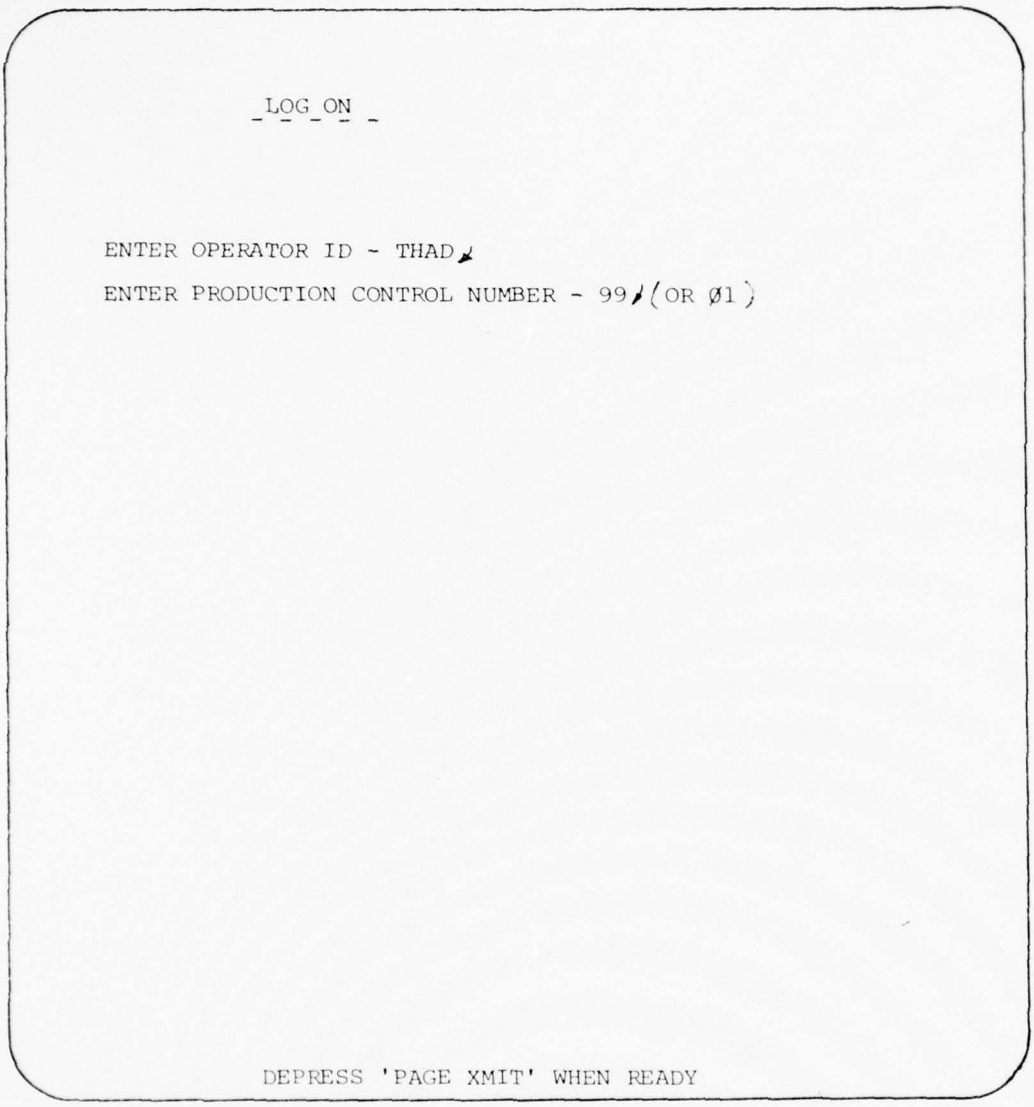
Set Address Switches to 100 (↑)

Depress: STOP START

(AGAIN)

19. Log on menu appears on CRT. (If LOG ON does not appear try pushing CR)

(GO TO MENU'S)


LOG ON
ENTER OPERATOR ID - THAD
ENTER PRODUCTION CONTROL NUMBER - 99 (OR Ø1)
DEPRESS 'PAGE XMIT' WHEN READY

MASTER MODE

X 1. CREATE A FILE

XX 2. REGISTER A FILE

3. DIGITIZE

4. EDIT

5. REMOTE JOB ENTRY

6. DIRECT GEOGRAPHIC POINT FEATURE EDIT

7. CREATE I/O FILTER

8. LIBRARY AND JOB STATISTICS NON PRIVILEGED

9. WORK STATION DIAGNOSTICS

10. LOG OFF

NOTE: X - Selected when a new file is first initiated
Not required for files already established

XX - Selected when previously created file is to be used

ENTER SELECTION NUMBER - X +↵
ENTER 'A' FOR ACCEPT, 'R' FOR REJECT

FILE CONTROL

- IDENTIFY FILE -

ENTER FILE NAME - DDRTØ1↵

ENTER DISK PACK ID - 12↵

DEPRESS 'PAGE XMIT' WHEN READY

FILE CONTROL

- DEFINE DATA CELL -

WAC NUMBER -↵

WAC CELL NUMBER -↵

WAG CELL NUMBER -↵

DIGITIZING AREA REFERENCE POINT

LATITUDE - DEG Ø43 MIN 37 SEC ØØ:ØØN

LONGITUDE - DEG Ø75 MIN 45 SEC ØØ:ØØW

TABLE RESOLUTION (MICRONS) - 2Ø↵

DEPRESS 'PAGE XMIT' WHEN READY

FILE CONTROL

- IDENTIFY SOURCE MANUSCRIPT -

SOURCE MANUSCRPT TYPE - SEARS POND

SHEET NUMBER - } NOT REQUIRED

EDITION NUMBER }

DEPRESS 'PAGE XMIT' WHEN READY

```
                    FILE CONTROL
                    ------------

                  - SPHEROID MODE -


Ø = ENTER AXES AND ECCENTRICITIES BELOW
1 - AIRY
2 = AMS
3 = BESSEL
4 = CLARKE 1866
5 = CLARKE 188Ø
6 = INTERNATIONAL
7 = KRASSOWSKI
8 = EVEREST
9 = FISCHER MERCURY

          ENTER CHOICE (Ø-9) - 5

MAJOR AXIS -
MINOR AXIS -                    } NOT REQUIRED
MAJOR ECCENTRICITY -
MINOR ECCENTRICITY -

               DEPRESS 'PAGE XMIT' WHEN READY
```

FILE CONTROL

- SOURCE REPRESENTATION -

MAP SCALE RECIPROCAL (IN HUNDREDS) - 24Ø↵

PROJECTION TYPE

1 = TRANSVERSE MERCATOR

2 = LAMBERT CONFORMAL

3 = MERCATOR

4 = POLYCONIC

ENTER CHOICE FROM ABOVE (1-4) - 4↵

PROJECTION PARAMETERS

CENTRAL MERIDIAN

- DEG Ø75 MIN. 41 SEC 15:00W↵

CHART LEFT LONGITUDE

- DEG. Ø75 MIN. 45 SEC. 00:00W↵

CHART BASE LATITUDE

- DEG Ø43 MIN. 37 SEC. 30:00N↵

LAMBERT CONFORMAL
LOWER STANDARD PARALLEL
DEG. MIN. SEC.
UPPER STANDARD PARALLEL
- DEG. MIN. SEC.

} NOT REQUIRED

DEPRESS 'PAGE XMIT' WHEN READY

FILE CONTROL

- FIGURE OF MERIT -

(NOT REQUIRED)

DEPRESS 'PAGE XMIT' WHEN READY

FILE CONTROL

- CONTROL POINT TYPE -

1. PROJECTION INTERSECT
2. UTM GRID
3. GEODETIC

ENTER SELECTION NUMBER - 3

FILE CONTROL

- PROJECTION INTERSECT -
- REGISTRATION CONTROL POINTS -

BOTTOM LATITUDE

- DEG. MIN. SEC.

TOP LATITUDE

- DEG. MIN. SEC.

LATITUDE INTERVAL

- DEG. MIN. SEC.

LEFT LONGITUDE

- DEG. MIN. SEC.

RIGHT LONGITUDE

- DEG. MIN. SEC.

LONGITUDE INTERVAL

- DEG. MIN. SEC.

(NOT REQUIRED)

DEPRESS 'PAGE XMIT' WHEN READY

FILE CONTROL

- UTM GRID -

- REGISTRATION CONTROL POINTS -

BOTTOM NORTHING -

TOP NORTHING -

NORTHING INTERVAL -

LEFT EASTING -

RIGHT EASTING -

EASTING INTERVAL -

ZONE -

(NOT REQUIRED)

DEPRESS 'PAGE XMIT' WHEN READY

FILE CONTROL

- GEODETIC CONTROL POINT -

ENTER NUMBER OF CONTROL POINTS - 4

DEPRESS 'PAGE XMIT' WHEN READY

FILE CONTROL

- GEODETIC CONTROL POINT -

POINT NUMBER (1 / 2 / 3 / 4) OF (4 / 4 / 4 / 4)

DOD ID -↵

SURVEY ORDER -↵

ELEVATION -↵

LATITUDE - Ø43 4Ø ØØ:ØØN↵ #1

LONGITUDE - Ø75 42 3Ø:ØØW↵

Ø43 4Ø ØØ:ØØN↵
Ø75 4Ø ØØ:ØØW↵ #2

Ø43 42 3Ø:ØØN↵
Ø75 42 3Ø:ØØW↵ #3

Ø43 42 3Ø:ØØN↵
Ø75 4Ø ØØ:ØØW↵ #4

DEPRESS 'PAGE XMIT' WHEN READY

FILE CONTROL

- GEODETIC CONTROL POINT -

1 - UPDATE A CONTROL POINT

2 - ADD A CONTROL POINT

3 - DELETE A CONTROL POINT

4 - CONTINUE

ENTER SELECTION NUMBER - 4

FILE CONTROL

- GEODETIC CONTROL POINT -

ENTER CONTROL POINT # -

(WHEN UPDATING A CONTROL POINT)

DEPRESS 'PAGE XMIT' WHEN READY

FILE CONTROL

- GEOGRAPHIC SECTION BOUNDING RECTANGLE -

LOWER LATITUDE - DEG. MIN. SEC.	Ø43°42'25:ØØ"N
LEFT LONGITUDE - DEG. MIN. SEC.	Ø75°45' ØØ:00"W
UPPER LATITUDE - DEG. MIN. SEC.	Ø43°44' 34:ØØ"N
RIGHT LONGITUDE - DEG. MIN. SEC.	Ø75°41' 02:00"W

REQUIRED ONLY IF GEO SECTIONING IS TO BE DONE

DEPRESS 'PAGE XMIT' WHEN READY

FILE CONTROL

1 - REVIEW DATA

2 - FILE CONTROL DATA COMPLETE

ENTER SELECTION NUMBER - 1 or 2

MASTER MODE

1. CREATE A FILE
2. REGISTER A FILE
3. DIGITIZE
4. EDIT
5. REMOTE JOB ENTRY
6. DIRECT GEOGRAPHIC POINT FEATURE EDIT
7. CREATE I/O FILTER
8. LIBRARY AND JOB STATISTICS NON PRIVILEGED
9. WORK STATION DIAGNOSTICS
10. LOG OFF

ENTER SELECTION NUMBER - 2↵
ENTER 'A' FOR ACCEPT, 'R' FOR REJECT

REGISTRATION

- IDENTIFY SOURCE FILE -

ENTER FILE NAME - DDRTØ1↵

ENTER DISK PACK ID - 12↵

DEPRESS 'PAGE XMIT' WHEN READY

REGISTRATION

- FILE CONTROL UPDATE -

1 UPDATE FILE CONTROL INFORMATION

2 ACCEPT FILE CONTROL INFORMATION

ENTER SELECTION NUMBER - 2

REGISTRATION

- ENTER TABLE LIMIT POINTS -

PLEASE EXECUTIVE THE FOLLOWING INSTRUCTIONS:

1. DEPRESS CURSOR BUTTON #2

2. PLACE CURSOR AT LOWER LEFT CORNER OF THE DOCUMENT AND DEPRESS CURSOR BUTTON #3

3. PLACE CURSOR AT UPPER LEFT CORNER OF THE DOCUMENT AND DEPRESS CURSOR BUTTON #3

4. PLACE CURSOR AT UPPER RIGHT CORNER OF THE DOCUMENT AND DEPRESS CURSOR BUTTON #3

5. PLACE CURSOR AT LOWER RIGHT CORNER OF THE DOCUMENT AND DEPRESS CURSOR BUTTON #5

6. DEPRESS CURSOR BUTTON #4

REGISTRATION

- IDENTIFY DESTINATION FILE -

ENTER FILE NAME - DDRTØ2↵

ENTER DISK PACK ID - 12↵

(WHEN FIRST REGISTERING
A FILE THIS MENU WILL
NOT COME UP)

DEPRESS 'PAGE XMIT' WHEN READY

REGISTRATION

- CONTROL POINT DIGITIZATION

PLEASE DEPRESS CURSOR BUTTON #2

REGISTRATION

- CONTROL POINT DIGITIZATION

CONTROL POINT # 1/2/3/4

LATITUDE - DEG. MIN. SEC.
LONGITUDE - DEG. MIN. SEC.
} FILLED IN ON SCREEN

RESIDUAL X RESIDUAL Y

PLEASE POSITION CURSOR AT INDICATED

LOCATION AND DEPRESS CURSOR BUTTON #3.

DURING CONTROL POINT EDIT:

SKIP POINT BY DEPRESSING BUTTON #4
EXIT EDIT BY DEPRESSING BUTTON #5

REGISTRATION

- CONTROL POINT DIGITIZATION -

CONTROL POINT #

NORTHING -

EASTING -

RESIDUAL X RESIDUAL Y

PLEASE POSITION CURSOR AT INDICATED LOCATION AND DEPRESS CURSOR BUTTON #3.

DURING CONTROL POINT EDIT:

SKIP POINT BY DEPRESSING BUTTON #4
EXIT EDIT BY DEPRESSING BUTTON #5

(NOT REQUIRED)

REGISTRATION

- CONTROL POINT DIGITIZATION -

1. RE-DIGITIZE A CONTROL POINT

2. CONTINUE

(Select 1 if control point may be in error -
otherwise 2)

ENTER SELECTION NUMBER - 2

REGISTRATION

- CONTROL POINT DIGITIZATION -

ENTER CONTROL POINT NUMBER -

(Used only when control point is to be re-digitized)

DEPRESS 'PAGE XMIT' WHEN READY

REGISTRATION RESIDUALS IN TRU'S

NO	X	Y
1	-1	3
2		3
3	2	3
4	-1	3

(X-Y residual volumes must be lower than 10
to be acceptable)

DEPRESS 'PAGE XMIT' WHEN READY

REGISTRATION

- RESIDUAL DISPOSITION -

1. ACCEPT RESIDUALS

2. UPDATE CONTROL POINTS

3. RE-DIGITIZE CONTROL POINTS

4. TERMINATE REGISTRATION PROCESS
   SAVING DESTINATION FILE

5. TERMINATE REGISTRATION PROCESS
   PURGING DESTINATION FILE

ENTER SELECTION NUMBER - 1 OR 3

REGISTRATION

- UPDATE ORIGINAL CONTROL POINTS -

1. UPDATE CONTROL POINTS

2. CONTINUE

ENTER SELECTION NUMBER - 2

REGISTRATION

- TABLE SECTION INFORMATION -

1. TABLE SECTION DESIRED

2. REGISTRATION COMPLETE

ENTER SECTION NUMBER - 2

REGISTRATION

- TABLE SECTION COORDINATES -

PLEASE EXECUTE THE FOLLOWING INSTRUCTIONS:

1. DEPRESS CURSOR BUTTON #2

2. PLACE CURSOR AT DESIRED SECTION VERTEX LOCATION AND DEPRESS CURSOR BUTTON #3.

3. REPEAT STEP #2 FOR EACH SECTION VERTEX LOCATION. A MAXIMUM OF EIGHT (8) VERTICES ARE ALLOWED. (COUNTER CLOCKWISE)

4. DEPRESS CURSOR BUTTON #4 AFTER ALL VERTICES HAVE BEEN ENTERED

(Required only if Table Sectioning is to be done)

DEPRESS 'PAGE XMIT' WHEN READY

MASTER MODE

1. CREATE A FILE
2. REGISTER A FILE
3. DIGITIZE
4. EDIT
5. REMOTE JOB ENTRY
6. DIRECT GEOGRAPHIC POINT FEATURE EDIT
7. CREATE I/O FILTER
8. LIBRARY AND JOB STATISTICS NON PRIVILEGED
9. WORK STATION DIAGNOSTICS
10. LOG OFF

ENTER SELECTION NUMBER 3
ENTER 'A' FOR ACCEPT, 'R' FOR REJECT

FEATURE CLASS SELECTION

1. ROADS
2. POPULATED PLACES
3. RAILROADS
4. CULTURE
5. BOUNDARIES
6. RELIEF
7. DRAINAGE
8. COASTAL HYDRO.
9. VEGETATION
10. NAVIGATION AIDS
11. PORTS/HARBORS
12. MARINE DANGER

ENTER SELECTION NUMBER - 1

FEATURE TYPE SELECTION

- ROADS -

1. HARD SURF, ALL WEATHER
2. LIGHT SURF, ALL WEATHER
3. LIGHT SURF, FAIR OR DRY
4. DIRT ROAD
5. CART TRACK
6. FOOTPATH
7. FIRE ROAD
8. WOOD ROAD
9. CORDUROY

ENTER SELECTION NUMBER - 1

DESCRIPTOR SELECTION

- ROADS -

ALIGNMENT

2. ACCURATE
3. APPROXIMATE
4. DOUBTFUL

USABILITY

7. PUBLIC
8. PRIVATE
9. PROPOSED
10. UNDER CONSTRUCTION
11. UNDER REPAIR
12. ABANDONED

WIDTH

14. ONE LANE
15. TWO LANES
16. THREE LANES
17. FOUR LANES
18. MORE THAN FOUR LANES
19. DIVIDED TWO LANE
20. DIVIDED FOUR LANE

23 CONTINUE DESCRIPTOR SELECTION

ENTER SELECTION NUMBER - 2/7/15/23

DESCRIPTOR SELECTION

- ROADS CONTINUED -

TERMINALS

2. CONNECTS TWO PUPULATED PLACES
3. CONNECTS WITH ONE POPULATED PLACES
4. THRU ROUTE
5. STREET

SIGNIFICANCE

7. VISUAL
8. RADAR
9. VISUAL AND RADAR

10. CONTINUE DESCRIPTOR SELECTION

(Not required)

ENTER SELECTION NUMBER - 10

DESCRIPTOR SELECTION

- ROADS CONTINUED -

ROUTE NUMBER -

NAME -

COMMENT -

(Not required)

DEPRESS 'PAGE XMIT' WHEN READY

DESCRIPTOR SELECTION

- RADAR DATA -

1. RADAR DATA DESIRED

2. HEADER IS COMPLETE

ENTER SELECTION NUMBER - 2

CLASS	-	ROADS
TYPE	-	HARD SURF, ALL WEA
SUBTYPE	-	
ALIGNMENT	-	ACCURATE
USABILIT		PUBLIC
WIDTH		TWO LANES
TERMINAL		
SIGNIFIC		
ELEVATION	-	
NAME	-	
COMMENTS TO BE PAVED		
RADAR DATA	-	

ENTER NO. REQUIRING CHANGE OR SFK #2 FOR ANNOTATION OR
TYPE 'A' OR PB#5 TO ACCEPT HEADER AS ABOVE

(IF HEADER IS ACCEPTED)

PB#1 - TRACE MODE

PB#2 - POINT TO POINT MODE

PB#5 - POINT FEATURE

PLOT PROCEDURE

On completion of digitizing session, and prior to Output Tape being made. Work Station System in Master Mode. (Executed by pressing BREAK key on alpha-numerics keyboard or ESCAPE on special function keyboard)

1. Select RJE from Master Mode menu (#5)
2. Select PLOT from RJE menu (#4)
3. Select all DATA from Data Filter menu (#1)
4. Enter appropriate data on In Progress menu -
5. Enter appropriate data on Plot menu
   (Table Verification)

> Note ea Destination File Name "DDATØ1" etc. must be different from previous file name either output or plot.

6. Select END OF JOB (#16) on RJE Task Selection menu--Mount Mag Tape (WRITE RING IN) (Scratch Tape) on Tape Drive -- unit select at Ø
7. Format Tape (at TTY)

   Push [ALT] Mode

   Push [CONT] [C]

   MCR> REA␣19␣NONE␣DT↵

   If LUN/DEV has already been assigned, TTY Responds: INCORRECT DEV

   (Ignore and continue)

   MCR> REA␣6␣MTØ␣NONE↵

   If LUN/DEV has already been assigned, TTY Responds: INCORRECT DEV

   (Ignore and continue)

   MCR> MTF␣R999999,DØ,N↵

   MTF: SCRATCH TAPE

   MCF> MTF␣R999999,DØF1↵

   (Tape moves-TTY Prints Msg)

   MTF: REEL FORMATTED

   MCR> MOU␣JOBXXX,0Ø↵ (XXX-No. From DEC Writer)

   MCR>

   Tape reel moves short distance, delays and then runs.

AD-A044 611 SYNECTICS CORP ROME N Y F/G 8/2
DIGITAL REVISION TECHNIQUES.(U)
AUG 77 T B KOLASSA, A J KREUTZER F30602-76-C-0104
UNCLASSIFIED CT-0727-W RADC-TR-77-262 NL

3 OF 3
ADA
044611

END
DATE
FILMED
10-77
DDC

At end of Plot Tape processing the Mag Tape rewinds, a message is printed out on DEC Writer and Statistical Data is printed out on the Line Printer.

8. Remove print out from line printer.

9. Dismount Mag Tape from Tape Drive.

- At Xynetics Plotter Station -

PLOT MENU's

MASTER MODE

1. CREATE A FILE
2. REGISTER A FILE
3. DIGITIZE
4. EDIT
5. REMOTE JOB ENTRY
6. DIRECT GEOGRAPHIC POINT FEATURE EDIT
7. CREATE I/O FILTER
8. LIBRARY AND JOB STATISTICS NON PRIVILEGED
9. WORK STATION DIAGNOSTICS
10. LOG OFF

ENTER SELECTION NUMBER 5
ENTER 'A' FOR ACCEPT, 'R' FOR REJECT

RJE

- REMOTE TASK SELECTION -

1. INPUT FROM A MAGNETIC TAPE
2. OUTPUT TO MAGNETIC TAPE
3. TRANSFORM TO GEOGRAPHICS
4. PLOT
5. GEOGRAPHIC TO TABLE
6. SECTION GEOGRAPHIC
7. SECTION TABLE
8. CLIP/JOIN
9. PANEL
10. SORT
11. MERGE
12. GENERALIZATION
13. GENERAL/LIS CONVERSION
14. GENERALIZED PLOT
15. GENERAL MEDIA TRANSFER
16. END OF JOB
17. CANCEL JOB

ENTER SELECTION NUMBER - 4↵

RJE

- PLOT -

ENTER TAPE DESTINATION FILE NAME - DDRTØ3↵
ENTER TAPE REEL NUMBER - 999999↵

ENTER SOURCE FILE NAME - DRTØ1↵
ENTER DISK PACK ID - 12↵

ENTER PLOT TYPE CODE - 1

1. TABLE PLOT
2. GEOGRAPHIC PLOT
3. FEATURE ID OF TABLE FILE
4. FEATURE ID OF GEOGRAPHIC FILE

ENTER ANNOTATION
AND SYMBOLIZATION CODE - 1

1. NO ANNOTATION OR SYMBOLIZATION
2. ANNOTATE NAME
3. ANNOTATE SPECIAL NUMERIC
4. SYMBOLIZATION
5. SYMBOLIZATION AND ANNOTATE NAME
6. SYMBOLIZATION AND ANNOTATE SPECIAL NUMERIC

DEPRESS 'PAGE XMIT' WHEN READY

RJE

- PLOT -

ENTER CHARACTER SIZE - 1

0. SMALL
1. NORMAL
2. LARGE

ENTER DEFULT POINT SYMBOL CODE - 1

1. YES
2. NO

ENTER PLOT DEFAULT FEATURE CODE - 1

1. REJECT DEFAULT FEATURES
2. PLOT DEFAULT FEATURES

ENTER DEFAULT PEN CODE (1-4) - 1

ENTER FILTER FILE NAME (OPTIONAL) -

DEPRESS 'PAGE XMIT' WHEN READY

RJE

- REMOTE TASK SELECTION -

1. INPUT FROM A MAGNETIC TAPE
2. OUTPUT TO MAGNETIC TAPE
3. TRANSFORM TO GEOGRAPHICS
4. PLOT
5. GEOGRAPHIC TO TABLE
6. SECTION GEOGRAPHIC
7. SECTION TABLE
8. CLIP/JOIN
9. PANEL
10. SORT
11. MERGE
12. GENERALIZATION
13. GENERAL/LIS CONVERSON
14. GENERALIZED PLOT
15. GENERAL MEDIA TRANSFER
16. END OF JOB
17. CANCEL JOB

ENTER SELECTION NUMBER - 16

XYNETICS PLOTTER OPERATION

Plotter interface CPU is normally preset for operation. The following procedures should produce necessary plot.

1. Turn on CPU power (Round red button upper right corner is lighted when power in ON).
2. Turn on TTY. To On Line.
3. Load plot data magnetic tape on tape drive. (Follow tape loading instructions in cabinet). (Tape drive should be OFF Line).
   Push LOAD - Tape slack is taken up.
   Push ON LINE -
4. Place plotting paper on plotter table
   Plotter head should be at extreme lower left corner. Lower pens by placing finger under pen holder and with other hand pull out on knobbed stem (——■) on right side of plotter head. Adjust pen height if needed.
5. Turn Plotter Power ON.
6. Turn Plotter Lights ON.
7. Turn Plotter Vacuum ON
8. Plot Mode should be on AUTO.
9. At TTY: (_____Underlined statements are put in by operator)
   ␣ = Space bar

   Type: RS (Reset)
   ØØ Ready
   ?? SC (Scale)
   ?? X = 1␣
   ?? Y = 1␣
   ØØ DONE
   ?? PL F=1␣ D=Ø␣
   ØØ DIMENSIONS:
   ØØ ØØ/99.992 Ø1ØØ.ØØØ

Plotter will start to plot alphanumeric data at lower left corner of plot sheet before plotting features. First to be plotted will be registration points.

10. To re-plot:

    ?? RW (Rewind Data Tape)

    ØØ DONE

    ?? PL F=1␣ D=Ø␣

    ØØ DIMENSIONS

    ØØ ØØ99.992 Ø1ØØ.ØØØ

11. SHUT DOWN

    Push pen holder up on Plotter Head

    TURN OFF: Plotter Vacuum

    REMOVE: Plot Paper

    TURN OFF: Plotter Lights

    Plotter Power

    TTY

    Dismount Mag Tape:

    Push RESET

    REWIND (When tape has returned to Load Point Push REWIND again)

    Remove Tape

OUTPUT PROCEDURE

On completion of digitizing session, and after PLOT tape has been made.

Work Station System in Master Mode.

(Executed by pressing BREAK key on alphanumeric keyboard on ESCAPE on Special Function Keyboard).

1. Select RJE from Master Mode (#5)
2. Select Output to Magnetic Tape from RJE (#2)
3. Select ALL DATA from data filler (#1)

> NOTE: Each Output File name (DDRTØ1, etc) must be different from previous file name either Output or plot

4. Enter appropriate data on IN PROGRESS menu
5. Enter appropriate data on OUTPUT TO MAG TAPE menu
6. Select END OF JOB (#16) on RJE TASK SELECTION menu.
   Mount mag tape on tape drive (Write Ring In)
7. Format Tape (at TTY)

   Push [ALT] mode

   Push [CONT] [C]

   MCR> REA␣19␣NONE␣DT↵ (IGNORE INCORRECT DEV MSG)

   MCR> REA␣6␣MTØ␣NONE↵ (IGNORE INCORRECT DEV MSG)

   MCR> MTF␣R999999,DØ,N↵

   MTF: SCRATCH TAPE

   MCR> MTF␣R999999,DØ,F1↵

   (tape moves - TTY prints message)

   MTF: REEL FORMATTED

   MCR> MOU␣JOBXXX,OØ↵ (XX=NO. from DEC writer)

   MCR>

   Tape reel moves short distance, delays and then runs.
   At End of Data SAV processing the Mag Tape rewinds, a message is printed out on DEC writer and statistical Data is printed out on the Line Printer.
8. Remove Print Out from Line Printer and Save.
9. Dismount Mag Tape mark tape reel, and log in DRT project Tape Log Record.

OUTPUT MENUS

MASTER MODE

1. CREATE A FILE
2. REGISTER A FILE
3. DIGITIZE
4. EDIT
5. REMOTE JOB ENTRY
6. DIRECT GEOGRAPHIC POINT FEATURE EDIT
7. CREATE I/O FILTER
8. LIBRARY AND JOB STATISTICS NON PRIVILEGED
9. WORK STATION DIAGNOSTICS
10. LOG OFF

ENTER SELECTION NUMBER 5 ↵
ENTER 'A' FOR ACCEPT, 'R' FOR REJECT

ENTER OPERATOR ID THAD↵

ENTER PRODUCTION CONTROL NO. 99 OR Ø1↵

DEPRESS 'PAGE XMIT' WHEN READY

RJE

-REMOTE TASK SELECTION-

1. INPUT FROM A MAGNETIC TAPE
2. OUTPUT TO MAGNETIC TAPE
3. TRANSFORM TO GEOGRAPHICS
4. PLOT
5. GEOGRAPHIC TO TABLE
6. SECTION GEOGRAPHIC
7. SECTION TABLE
8. CLIP/JOIN
9. PANEL
10. SORT
11. MERGE
12. GENERALIZATION
13. GENERAL/LIS CONVERSION
14. GENERALIZED PLOT
15. GENERAL MEDIA TRANSFER
16. END OF JOB
17. CANCEL JOB

ENTER SELECTION NUMBER - 2

RJE

-OUTPUT TO MAGNETIC TAPE-

ENTER TAPE DESTINATION FILE NAME - DDRTØ2↙

ENTER TAPE REEL NUMBER - 999999↙

ENTER SOURCE FILE NAME - DDRTØ1↙

ENTER DISK PACK ID - 12↙

INFORMATION REQUESTED BELOW IS OPTIONAL

ENTER OPTIONAL INPUT FILE NAME -

ENTER DISK PACK ID -

OR

ENTER TAPE REEL NUMBER

DEPRESS 'PAGE XMIT' WHEN READY

RJE

-REMOTE JOB IN PROGRESS-

JOB NUMBER -

PRODUCTION CONTROL NUMBER -

TASKS WITHIN JOB -

MINUTES UNTIL JOB BEGINS -

THIS INFORMATION IS FILLED IN ON CRT

1. WAIT FOR RESULTS
2. DON'T WAIT FOR RESULTS

ENTER SELECTION NUMBER - 2

RJE

-REMOTE TASK SELECTION -

1. INPUT FROM A MAGNETIC TAPE
2. OUTPUT TO MAGNETIC TAPE
3. TRANSFORM TO GEOGRAPHICS
4. PLOT
5. GEOGRAPHIC TO TABLE
6. SECTION GEOGRAPHIC
7. SECTION TABLE
8. CLIP/JOIN
9. PANEL
10. SORT
11. MERGE
12. GENERALIZATION
13. GENERAL/LIS CONVERSION
14. GENERALIZED PLOT
15. GENERAL MEDIA TRANSFER
16. END OF JOB
17. CANCEL JOB

ENTER SELECTION NUMBER - 16

INPUT PROCEDURES

Work Station System in Master Mode

Input Tape mounted on Mag Tape drive, unit select Ø, write ring out.

1. Select REMOTE JOB ENTRY (RJE) from Master Mode.
2. Enter appropriate data in menus
   - Input File (Source File) name is number of Mag Tape being input (DDRTØ8,etc.)
   - Reel Number = 999999.
3. Select END OF JOB (EOJ) on RJE TASK SELECTION MENU.
4. At TTY:

   Type: ALT MODE, CONT C

   MCR> REA␣19␣NONE␣DT↵

   (May receive incorrect DEV message-ignore and continue)

   MCR> REA␣6␣MTØ␣NONE↵

   (May receive INCORRECT DEV Message-Ignore and continue)

   MCR> MOU␣JOBXXX,IØ↵ (XXX-Number from DEC Writer)

   Tape will read in to disk pack specified during menu manipulation at WS.

INPUT MENU'S

MASTER MODE

1. CREATE A FILE
2. REGISTER A FILE
3. DIGITIZE
4. EDIT
5. REMOTE JOB ENTRY
6. DIRECT GEOGRAPHIC POINT FEATURE EDIT
7. CREATE I/O FILTER
8. LIBRARY AND JOB STATISTICS NON PRIVILEGED
9. WORK STATION DIAGNOSTICS
10. LOG OFF

ENTER SELECTION NUMBER - 5

ENTER 'A' FOR ACCEPT, 'R' FOR REJECT

RJE

-REMOTE TASK SELECTION-

1. INPUT FROM A MAGNETIC TAPE
2. OUTPUT TO MAGNETIC TAPE
3. TRANSFORM TO GEOGRAPHICS
4. PLOT
5. GEOGRAPHIC TO TABLE
6. SECTION GEOGRAPHIC
7. SECTION TABLE
8. CLIP/JOIN
9. PANEL
10. SORT
11. MERGE
12. GENERALIZATION
13. GENERAL/LIS CONVERSION
14. GENERALIZED PLOT
15. GENERAL MEDIA TRANSFER
16. END OF JOB
17. CANCEL JOB

ENTER SELECTION NUMBER - 1

```
                              RJE
                    -INPUT FROM MAGNETIC TAPE-

ENTER TAPE SOURCE FILE NAME - DDRTØ1↵
ENTER TAPE REEL NUMBER - 999999↵

ENTER DESTINATION FILE NAME - DDRTØ4↵
ENTER DISK PACK ID - 12↵

INFORMATION REQUESTED BELOW IS OPTIONAL
---------------------------------------

ENTER FILTER FILE NAME -
ENTER RESIDUAL FILE NAME -
ENTER RESIDUAL DISK PACK ID -
          OR
ENTER RESIDUAL TAPE REEL NUMBER -

                DEPRESS 'PAGE XMIT' WHEN READY
```

RJE

-REMOTE TASK SELECTION-

1. INPUT FROM A MAGNETIC TAPE
2. OUTPUT TO MAGNETIC TAPE
3. TRANSFORM TO GEOGRAPHICS
4. PLOT
5. GEOGRAPHIC TO TABLE
6. SECTION GEOGRAPHIC
7. SECTION TABLE
8. CLIP/JOIN
9. PANEL
10. SORT
11. MERGE
12. GENERALIZATION
13. GENERAL/LIS CONVERSION
14. GENERALIZED PLOT
15. GENERAL MEDIA TRANSFER
16. END OF JOB
17. CANCEL JOB

ENTER SELECTION NUMBER - 16

LOAD MAGNETIC TAPE ON TAPE DRIVE

1. Push POWER ON
2. Push BRAKE RELEASE
3. Mount tape reel, insuring reel is completely on spindle and string tape through drive mechanism and onto take-up reel.
4. Push LOAD
5. Set unit Select to Ø.
6. Push OFFLINE
7. Push FWD, STOP, START (Tape goes to load point)
8. Push ONLINE

SUPPLEMENTARY ROUTINES

TO OBTAIN LIST OF FILES ON DISK

(Line Printer must be On Line)

MCR> DPD↵ (Disk Pack Directory)

DRIVE 1, PACK Ø12 BLKS 228, (P,L OR M?) P↵

Printer Prints Out Data

TO CHECK LUN/DEVICE ASSIGNMENT

MCR> DEV↵

TTY prints out assignment directory

To STOP print out type CONT C

TO PURGE DISK FILES

(Files must be closed)

MCR> PRG XXXXNN, Ø12↵

Disk Pack No.(Optional)

TO CLOSE OPEN FILE

(Cannot be used when file was not properly closed '"X" in open column DPD print out)

MCR> CLS␣XXXXNU,␣Ø12↵

Disk Pack No. (Optional)

TO TERMINATE JOB

MCR> TER␣JXXX↵

GLOSSARY

BOOT	Installation of specific programs to initialize processing systems.
COLD BOOT	Initialization from complete off status
WARM BOOT	Initialization when some previous intialization has been done, second set in initialization process.
CONT	Continue
CPU	Central Processing Unit, Computer
CRT	Cathode Ray Tube, synonym for control terminal
DEC	Digital Equipment Corporation
DEV	Device
DT	DEC Tape
DR	Drive
DRT	Digital Revision Techniques
ECC	Experimental Compilation Console. The CRT physically associated with the PDP-15 hardware configuration but not specifically a part of the LIS. CRT Terminal can be used in lieu of TTY.
FWD	Forward
EOJ	End of Job
ID	Identification, control number, device assignment number
LH	Left Hand
LP	Line Printer
MT	Magnetic Tape
Paper Tape	Punched tape used to insert computer systems.
PL	Plot
RES	Restore

RH	Right Hand
RJE	Remote Job Entry
RS	Reset
SAV	Save
SC	Scale
SW	Switch
TTY	Teletypwriter
TRA	Transfer

SYMBOLS

␣ = Space/Space Bar

↙ = Carriage Return

DRT TIME DATA COLLECTION						METHOD:
REV CALL NO.	CALL DESCRIPTION	EDIT/REVISION FUNCTION	START	STOP	ELAPSED TIME	COMMENTS

Attachment # 2

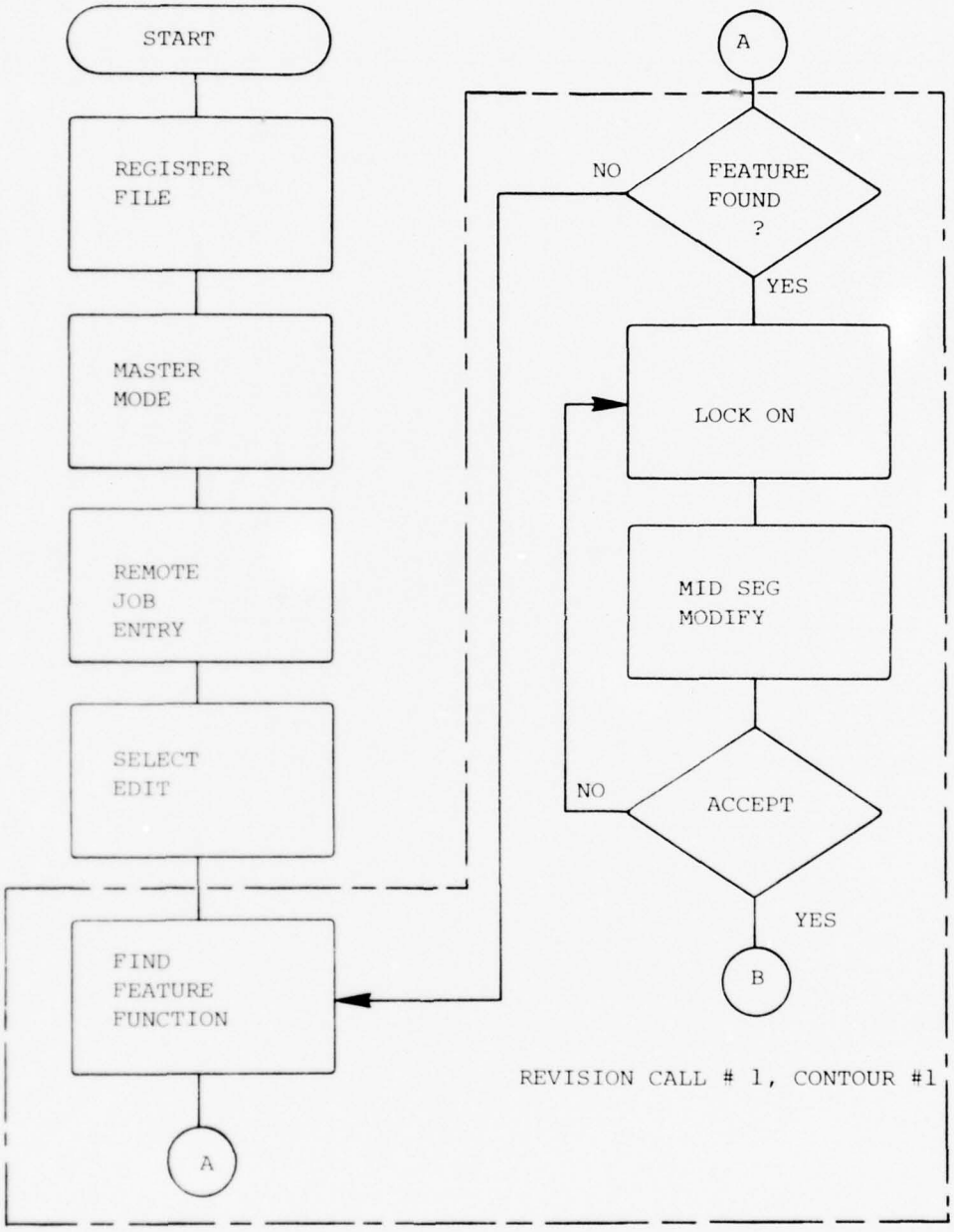
Attachment # 3
DRT Test Plan

REVISION METHOD COMPARATIVE TIME DATA					
REV CALL NO	REVISION CALL DESCRIPTION	LIS EDIT PROCESS	DRT PROCESS		
		TOTAL EDIT TIME	DIGITI-ZATION CODING	SYN BEP PROC	TOTAL
1	Adjust contour (4) as indicated				
2	Change road to light duty				
3	Add dam, lake, delete swamp and streams (2)				
4	Add contour as indicated. Add Spot Elevation 1833				
5	Align roads and change to light duty, add (extend) footpath				
6	Add streams and adjust contours (4)				
TOT					

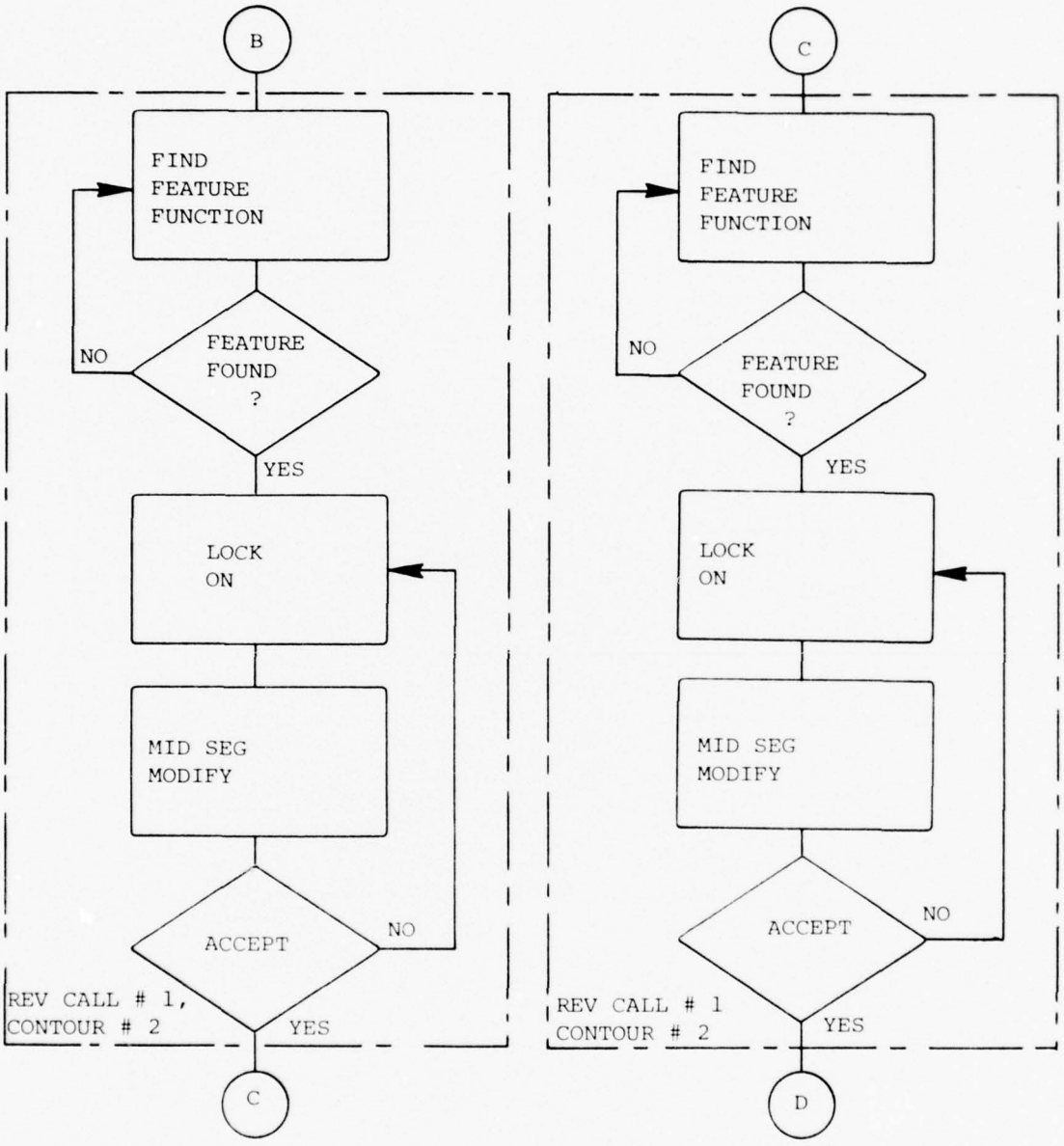
ATTACHMENT 4, DRT TEST PLAN

LIS EDIT PROCESS

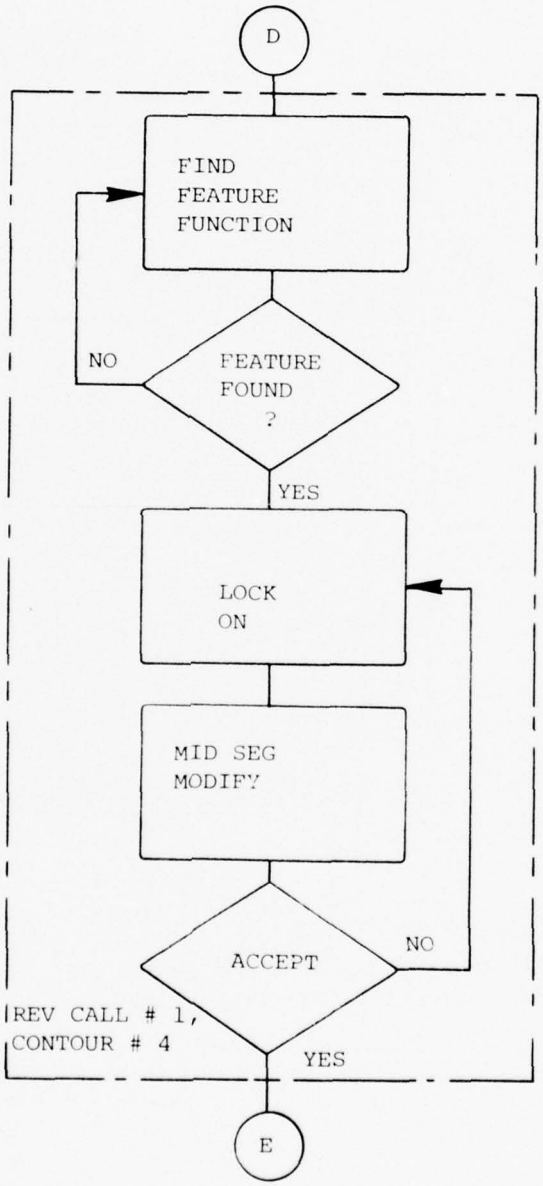
Status Assumed: LIS initialized, work station activated, current data file resident on disk. Edit to be completed during one session.

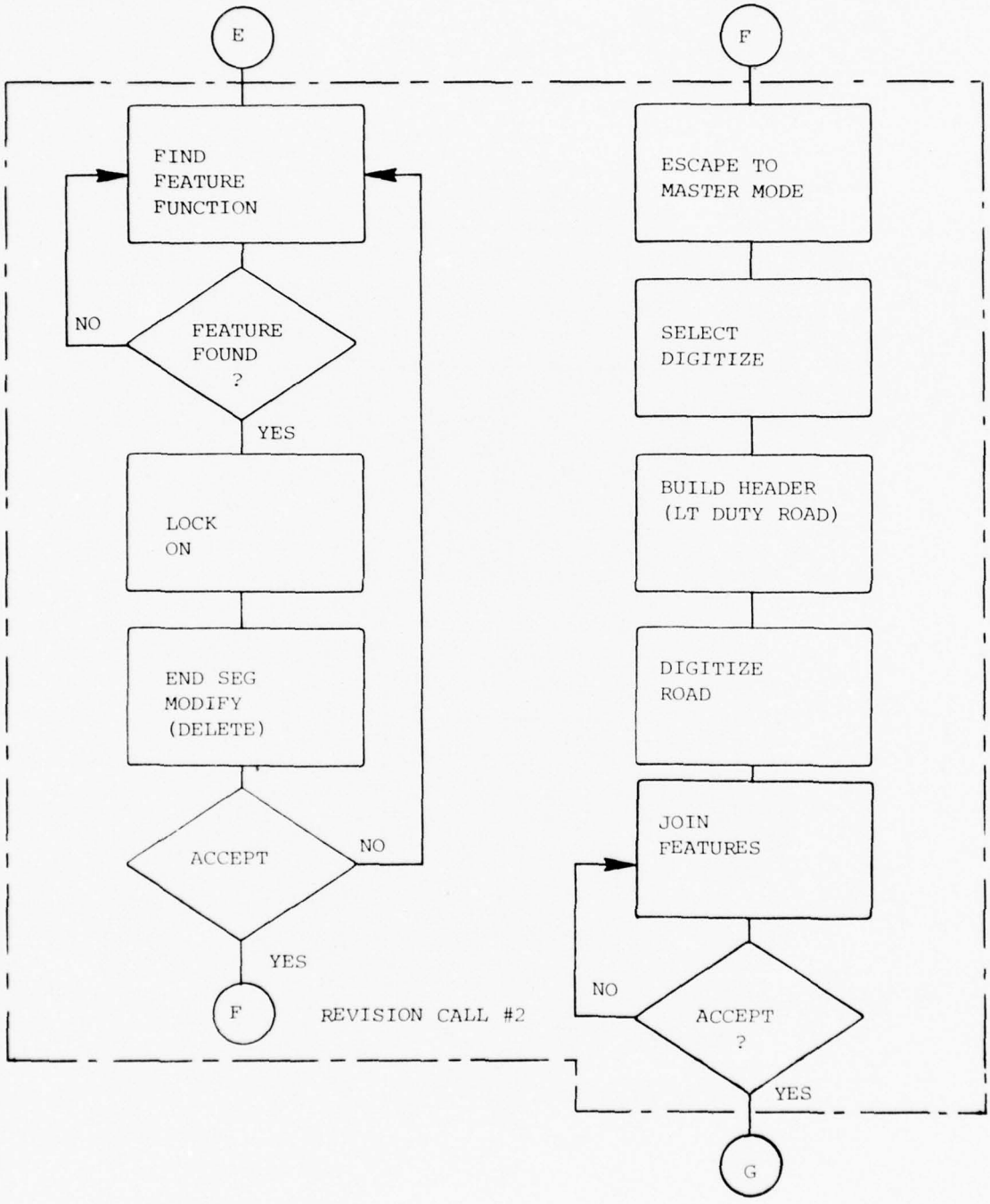


LIS Edit Process

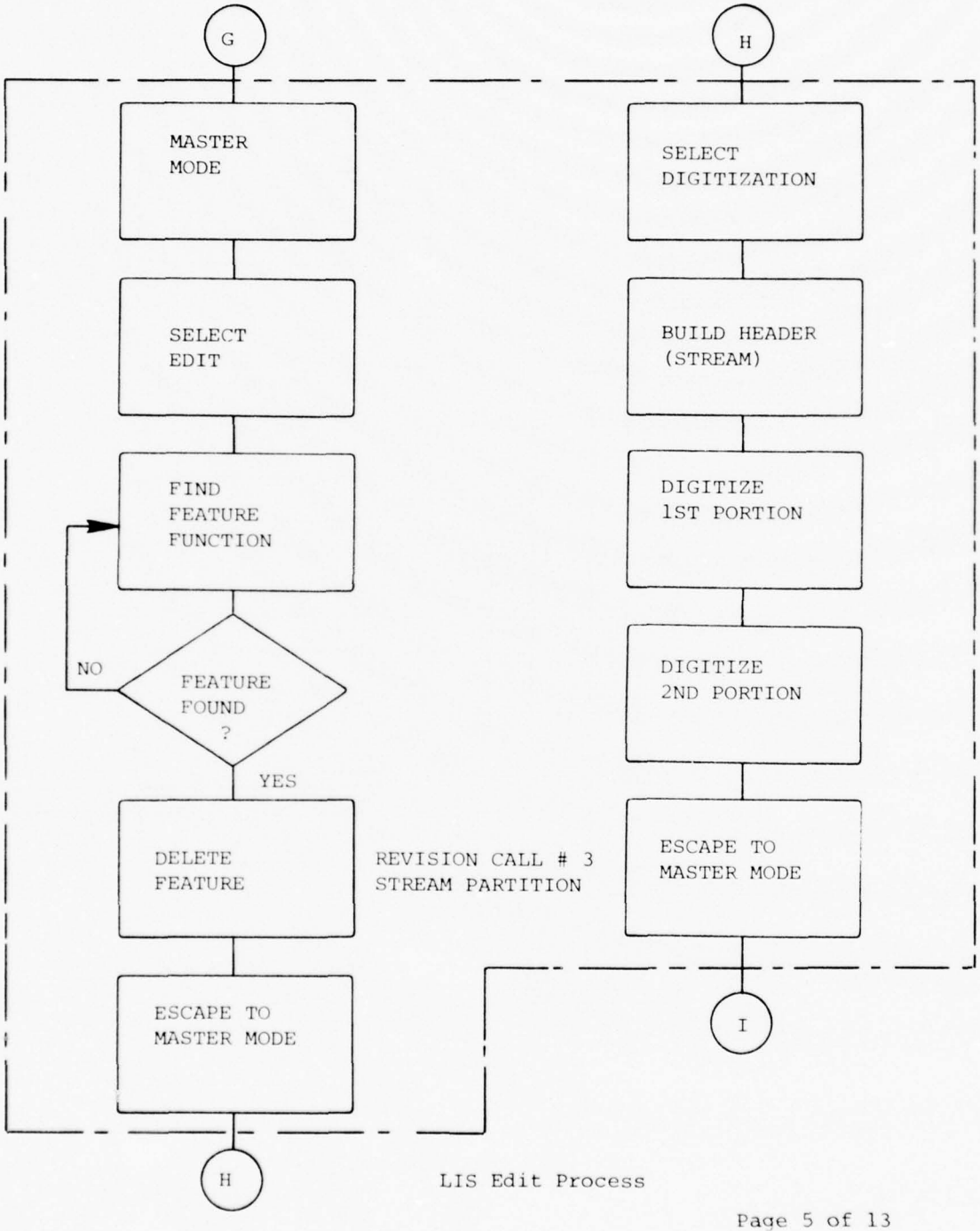


LIS Edit Process

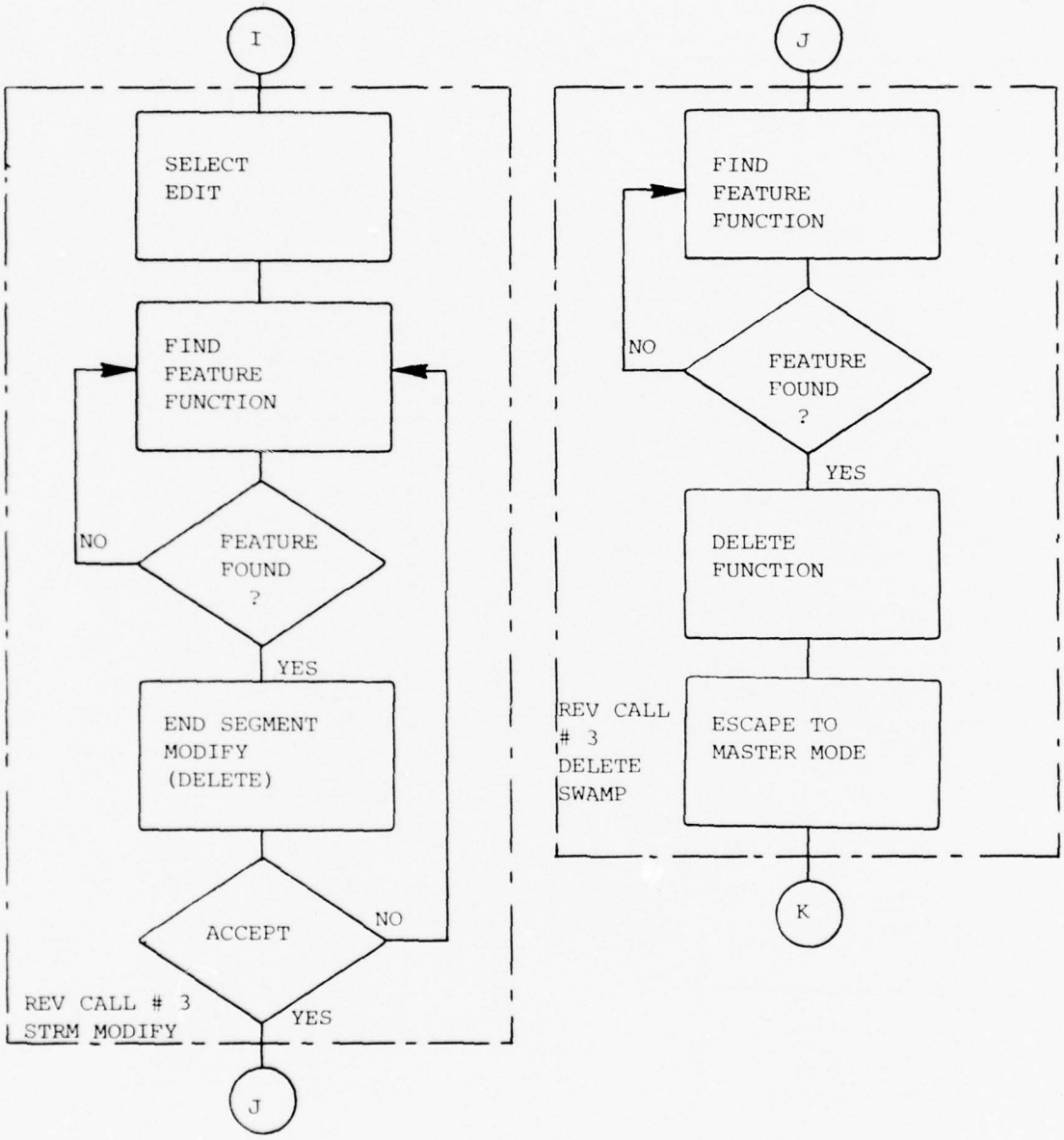

D
FIND
FEATURE
FUNCTION
NO
FEATURE
FOUND
?
YES
LOCK
ON
MID SEG
MODIFY
ACCEPT
NO
REV CALL # 1,
CONTOUR # 4
YES
E



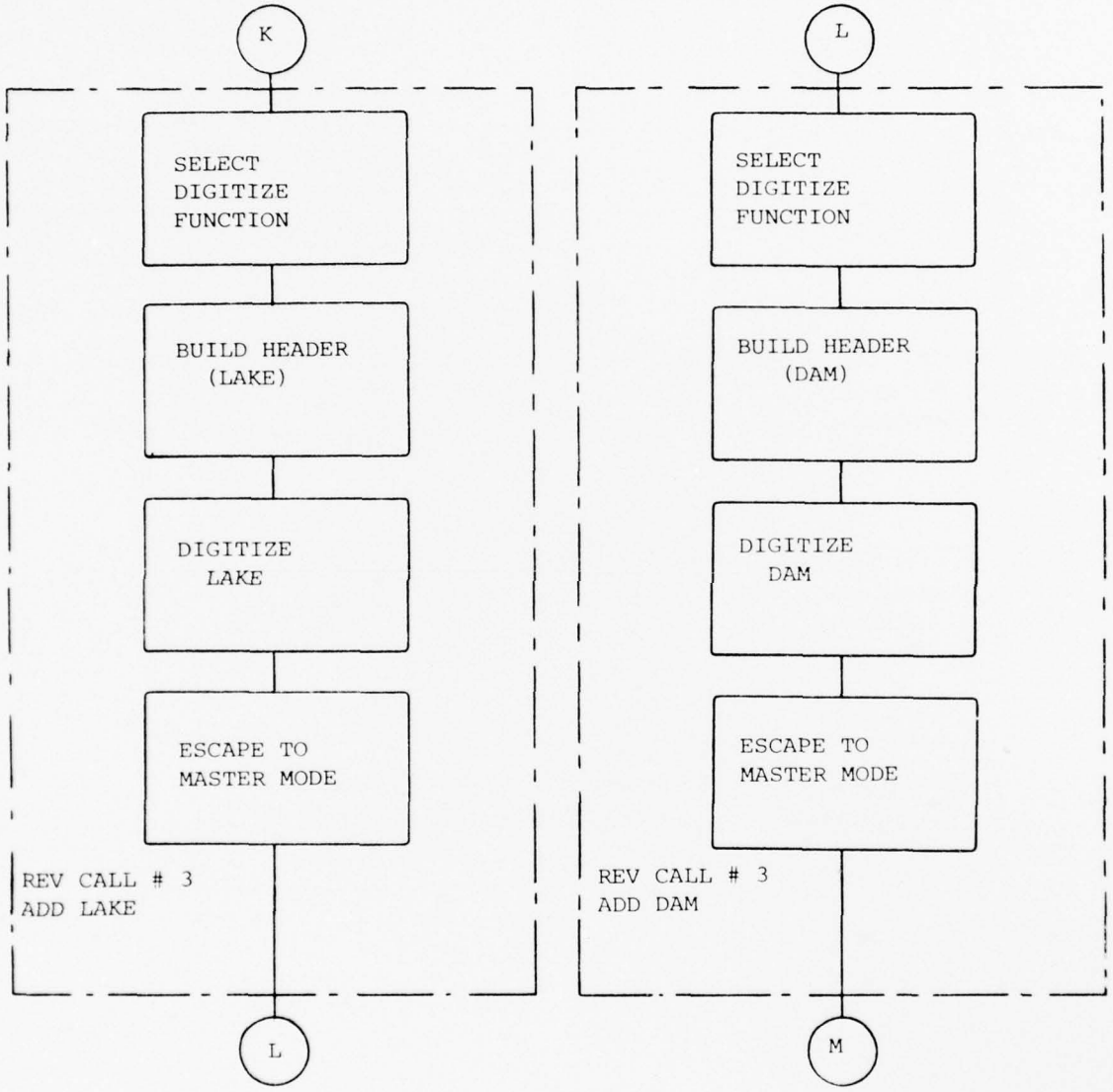
LIS EDIT PROCESS



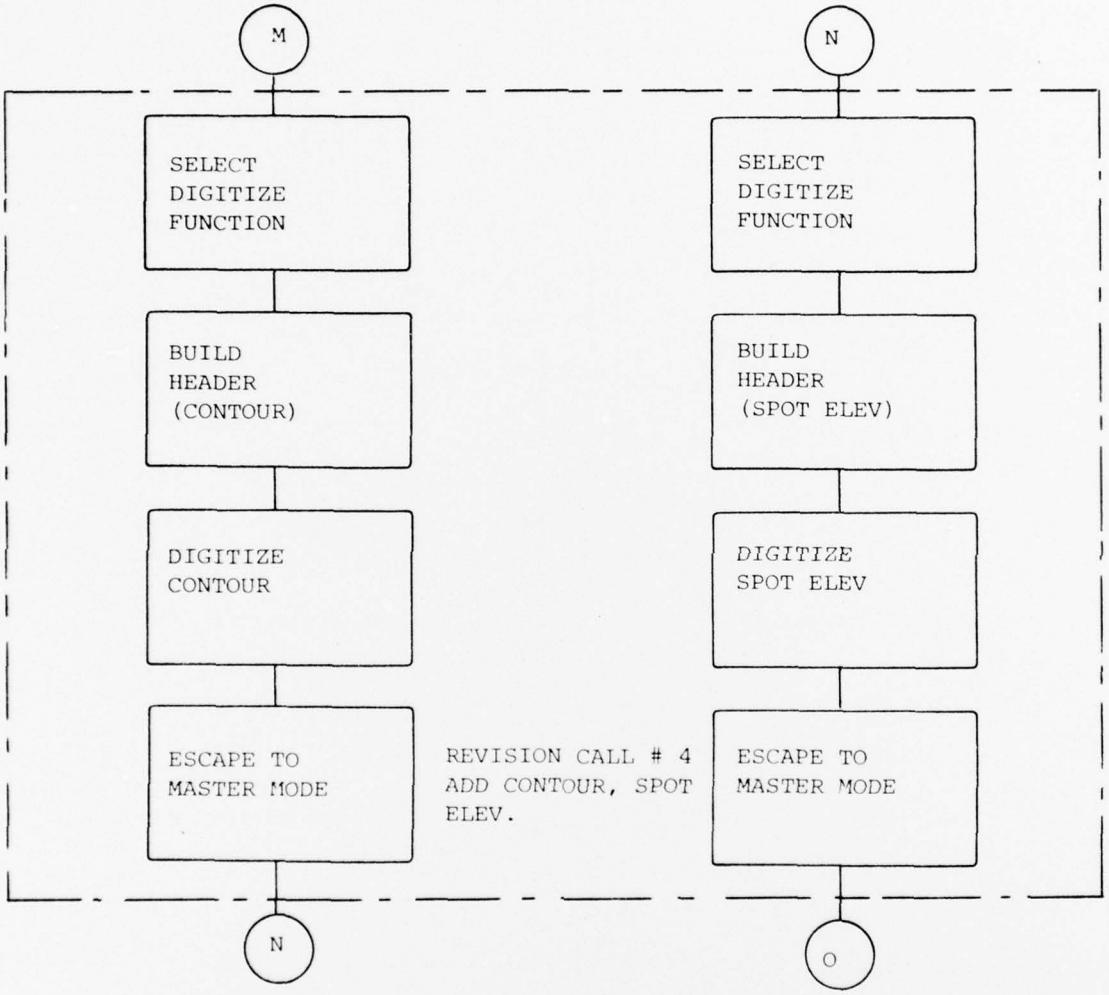
LIS Edit Process



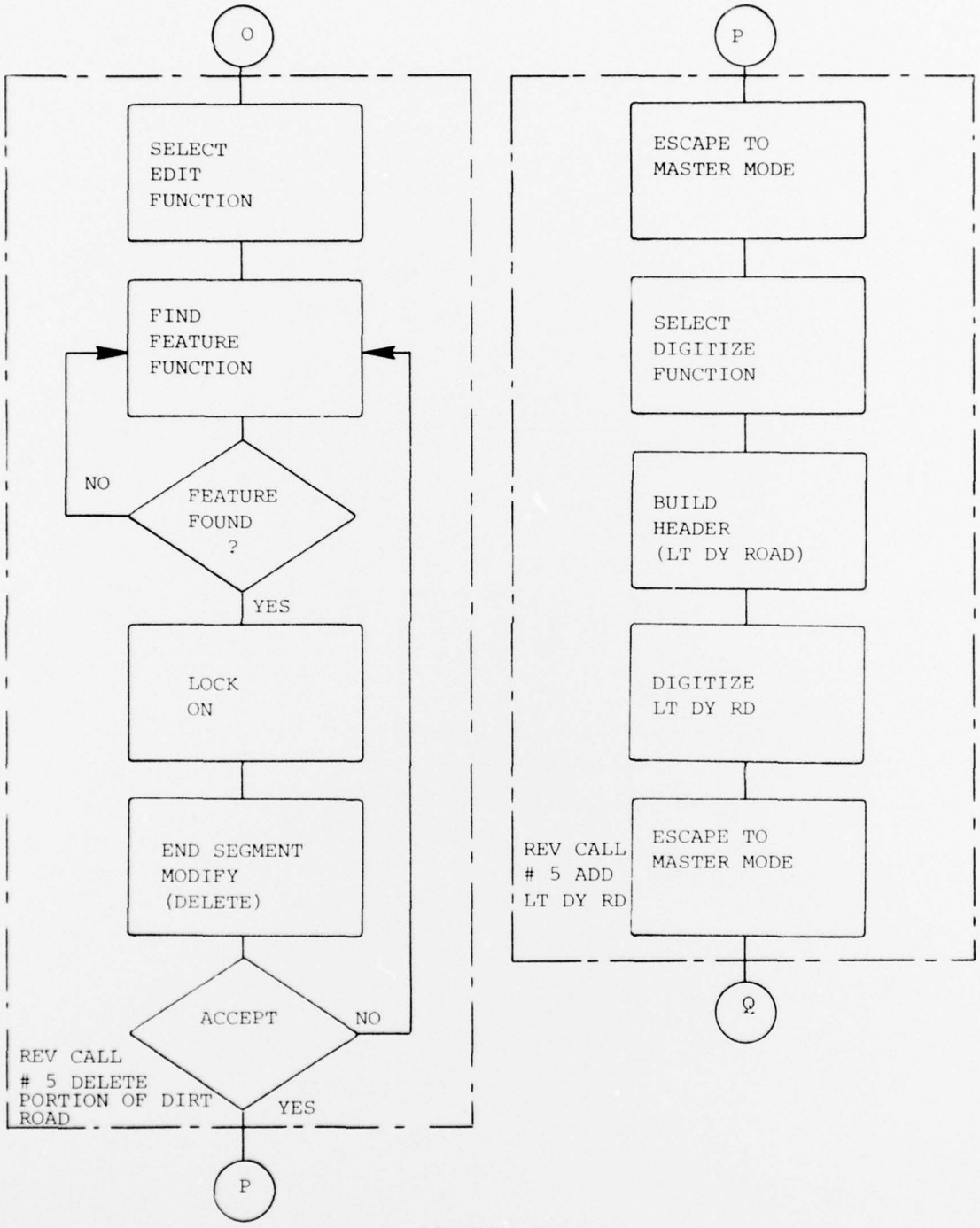
LIS Edit Process



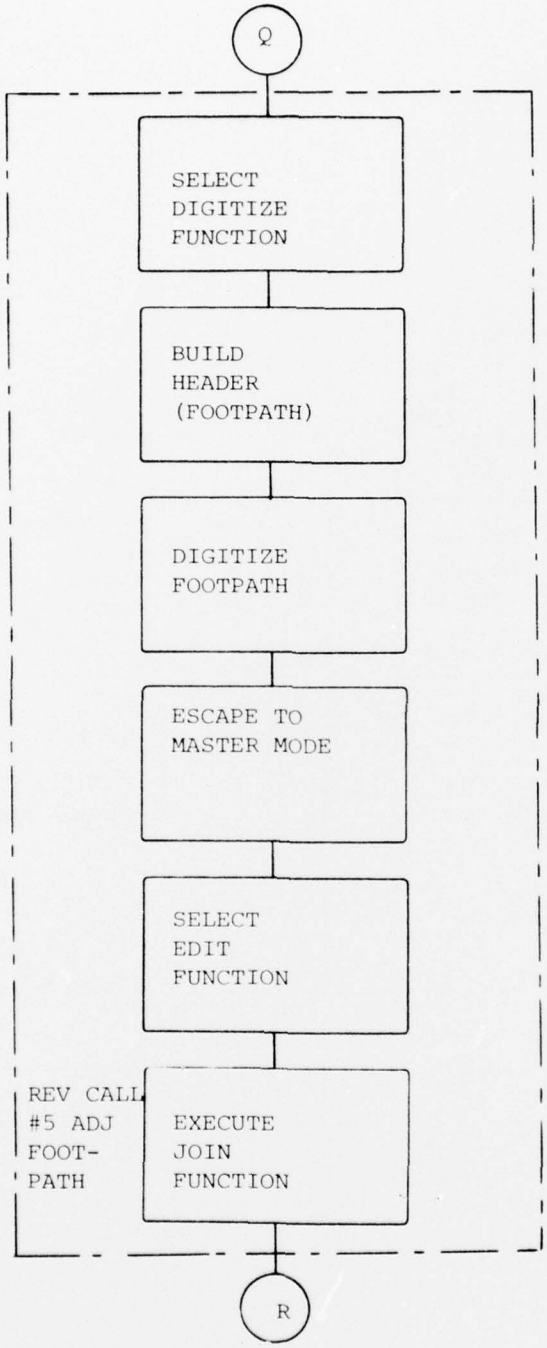
LIS Edit Process



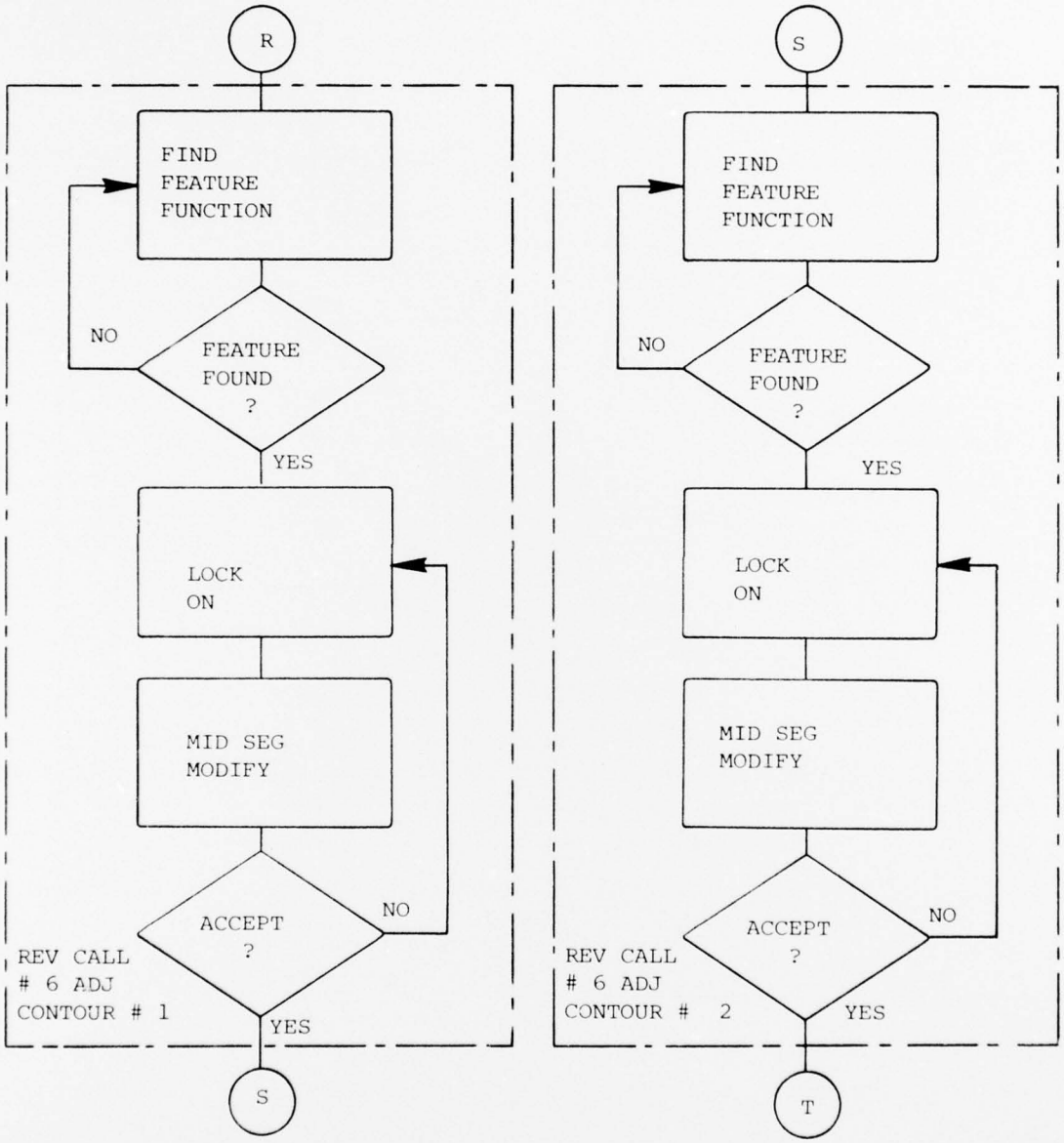
LIS Edit Process



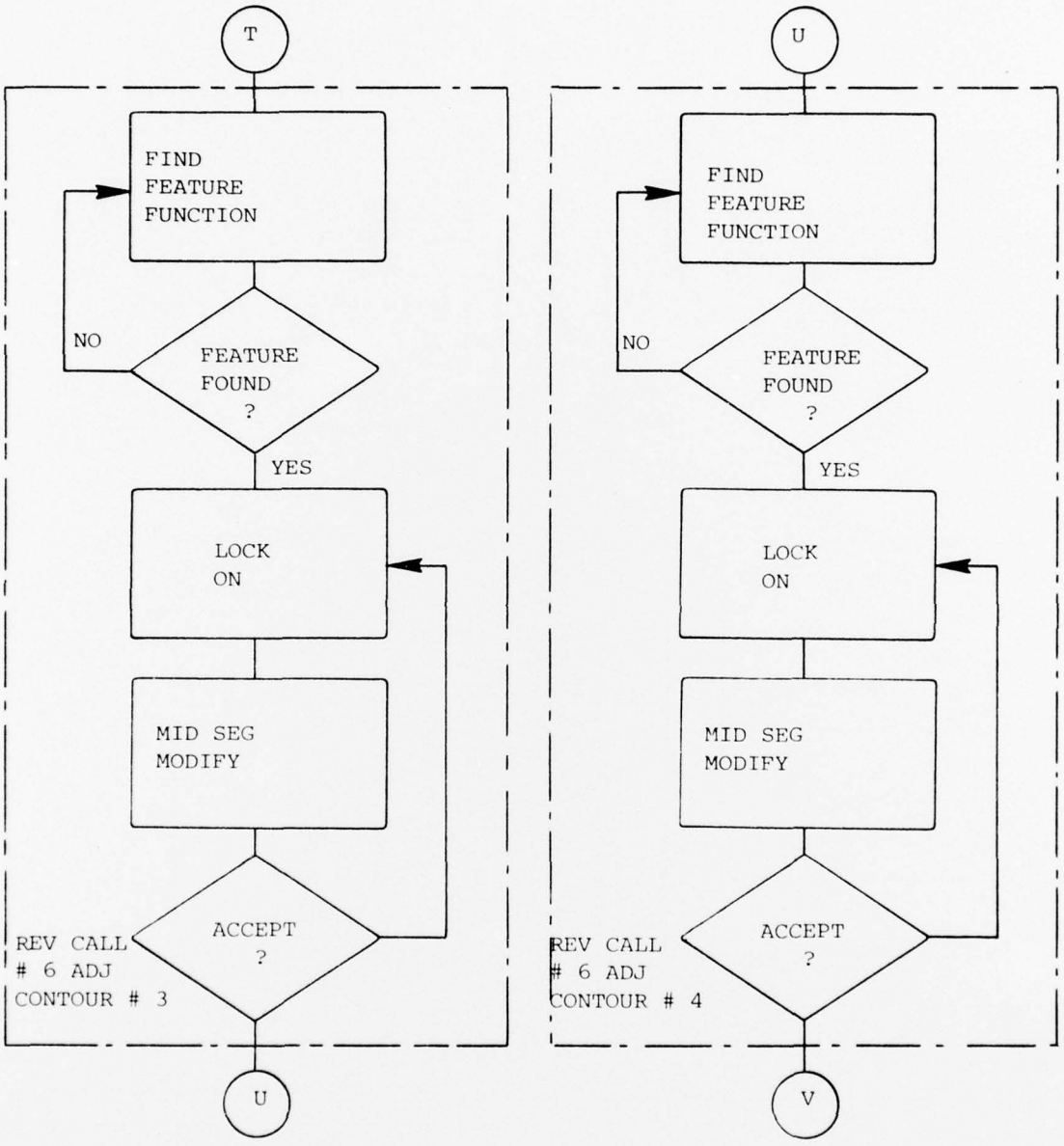
LIS Edit Process



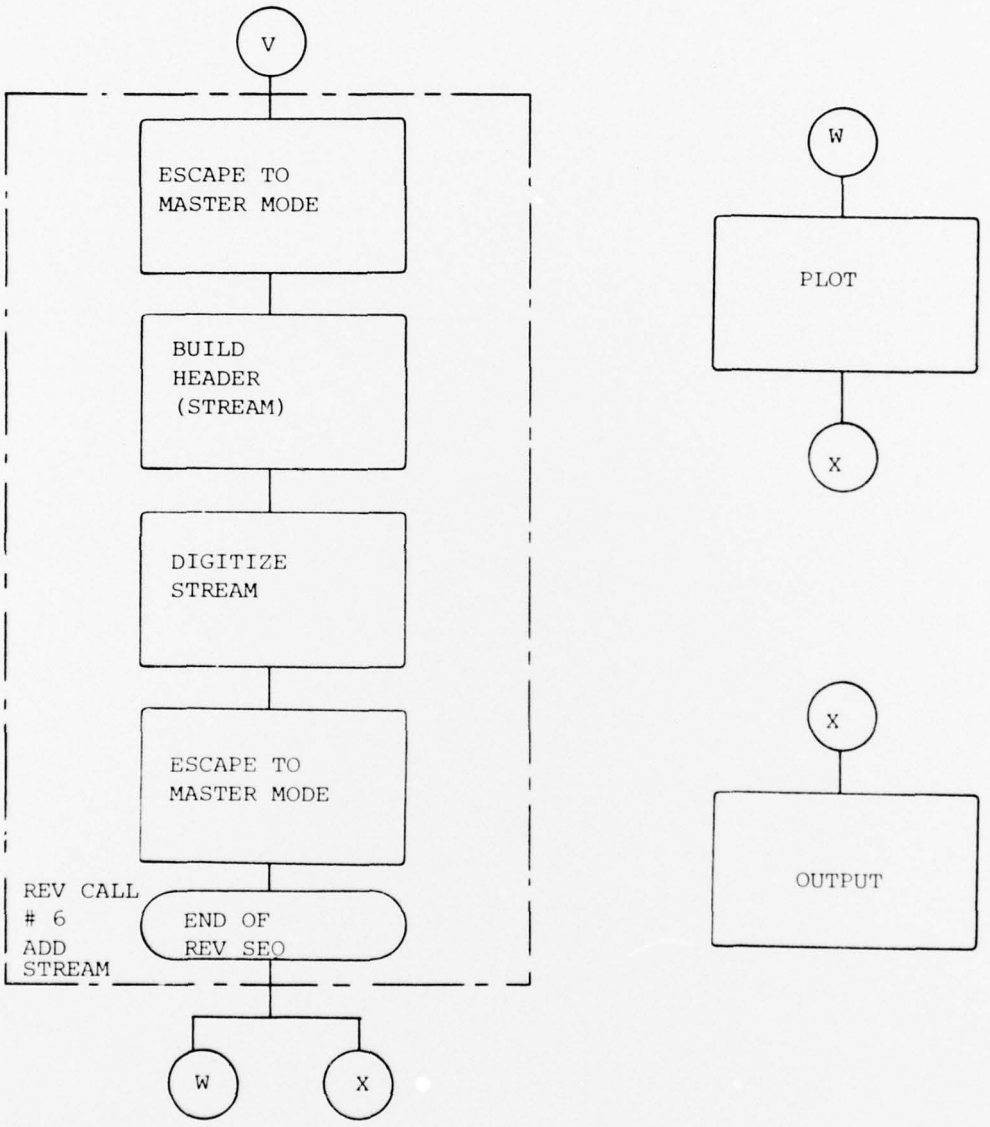
LIS Edit Process



LIS Edit Process



LIS Edit Process

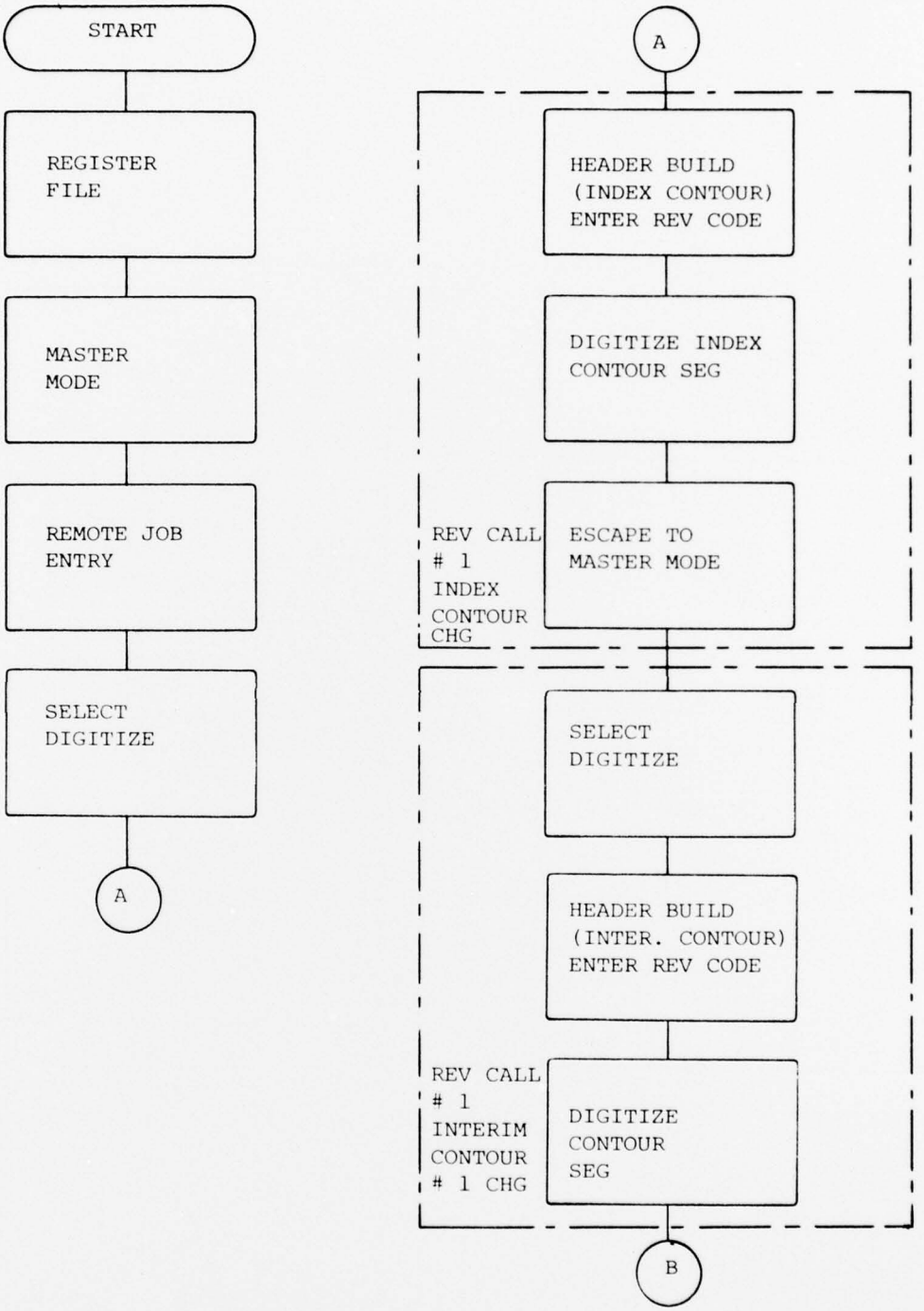


LIS Edit Process

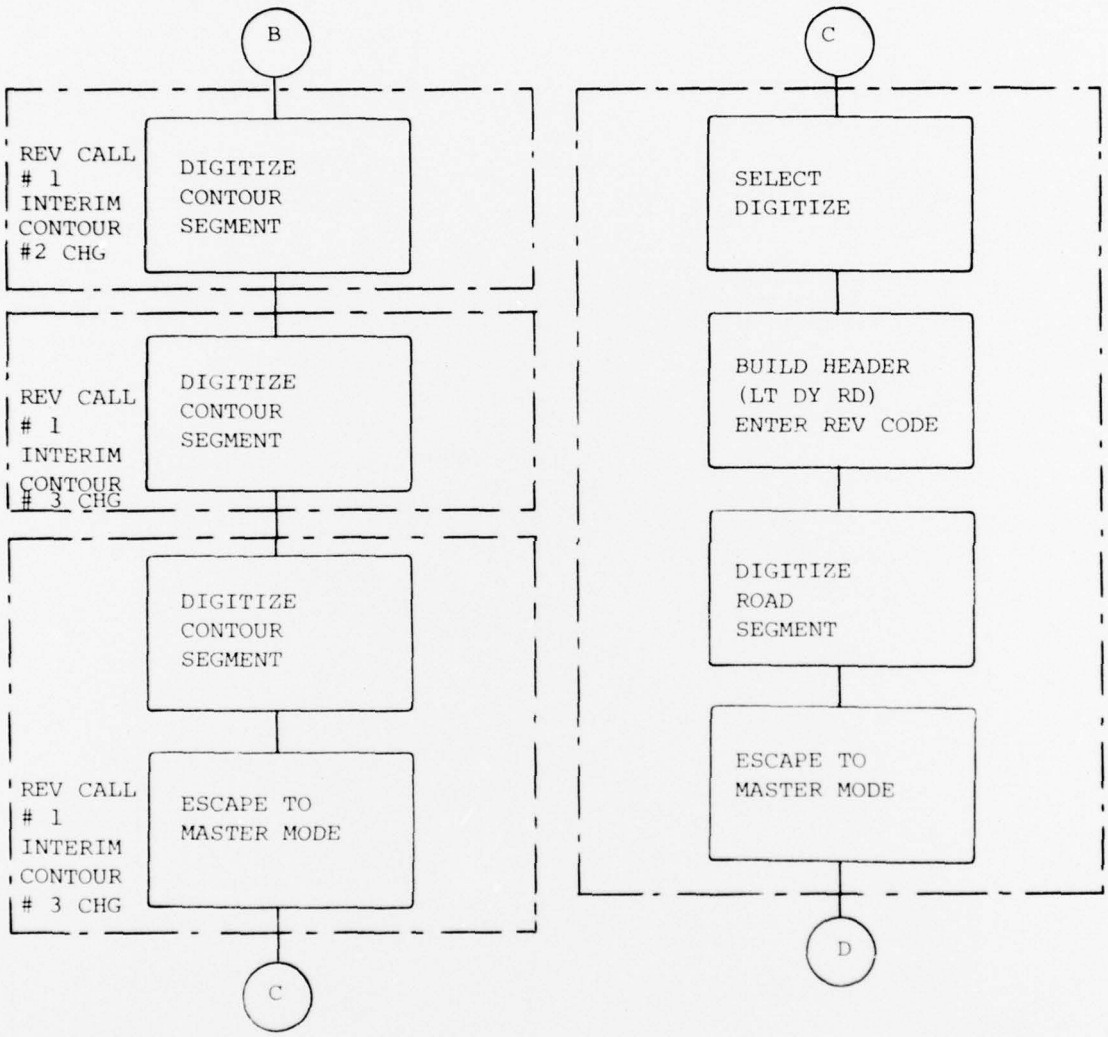
ATTACHMENT 5, DRT TEST PLAN

DRT REVISION PROCESS

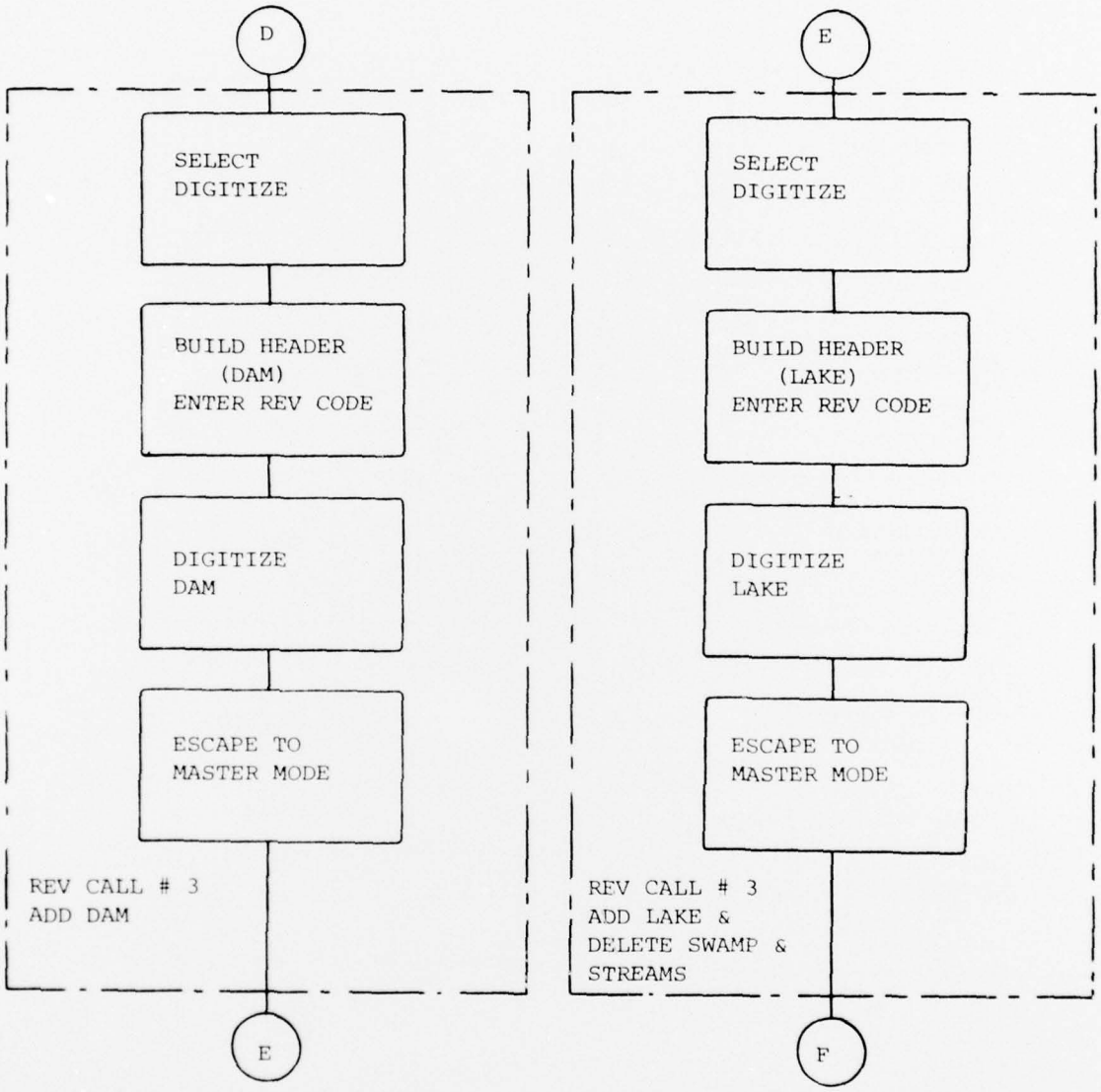
Status Assumed: LIS initialized, work station activiated, current data file resident on disk. Revision to be accomplished during single work session.



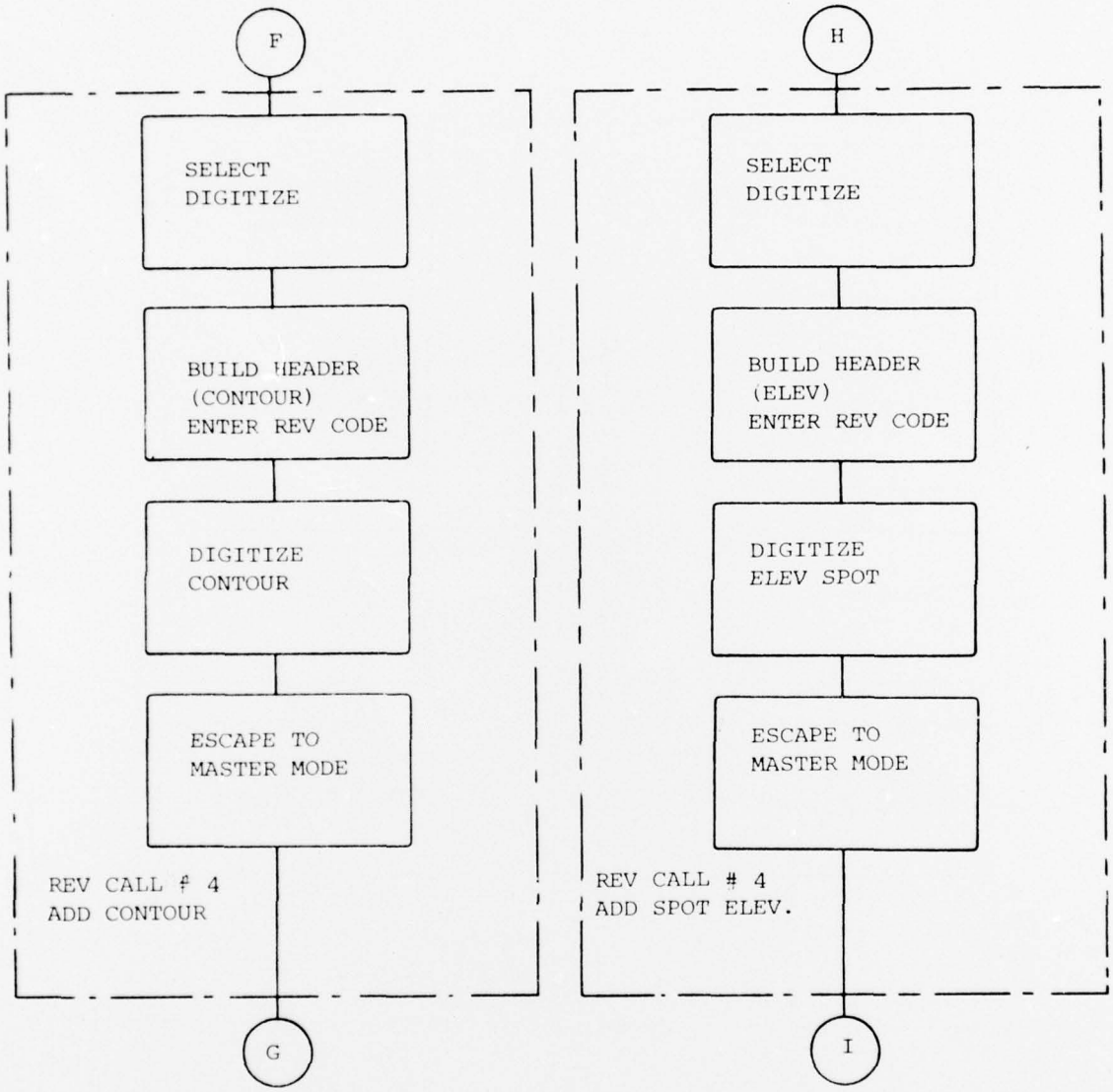
DRT Revision Process



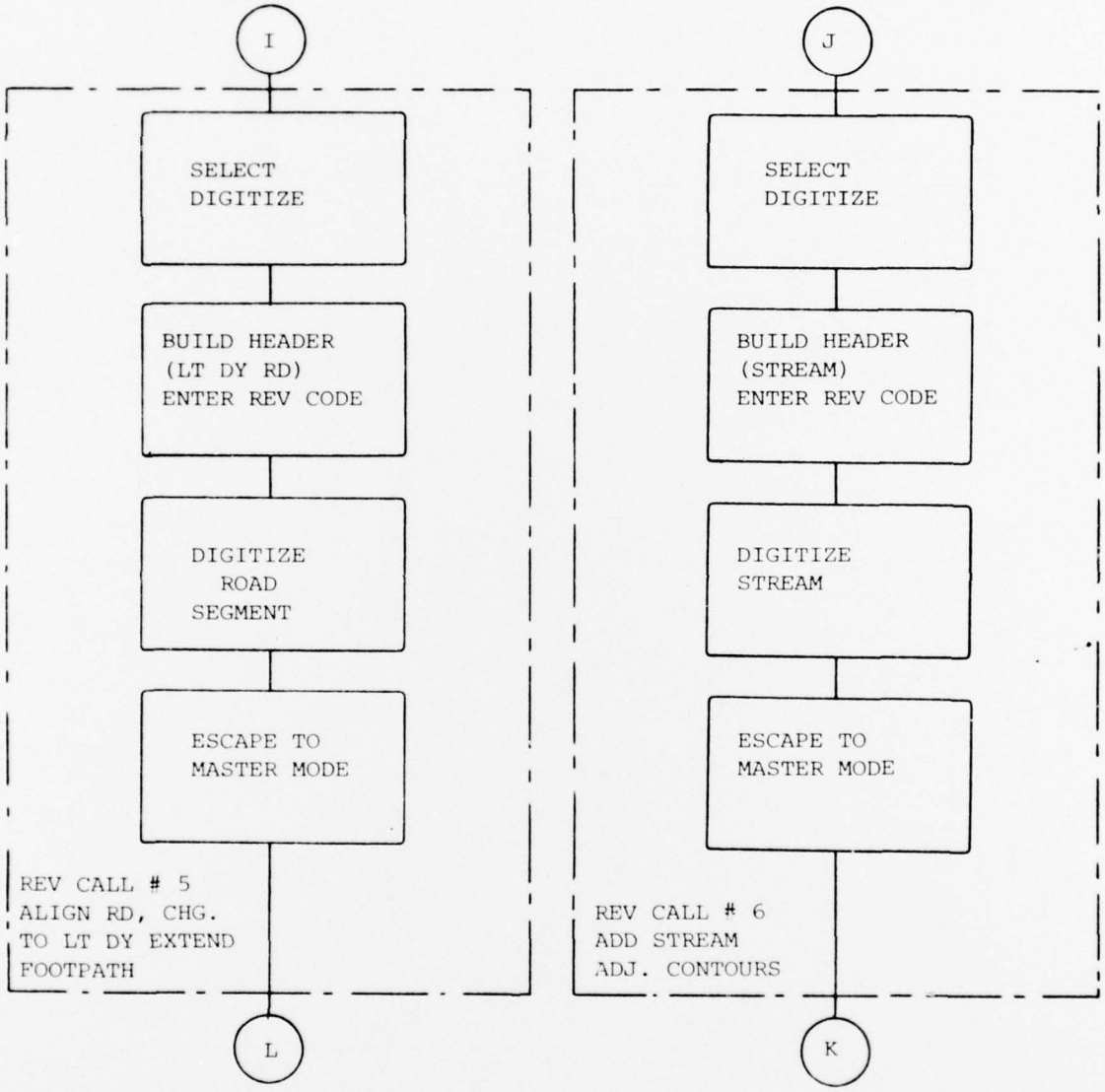
DRT Revision Process



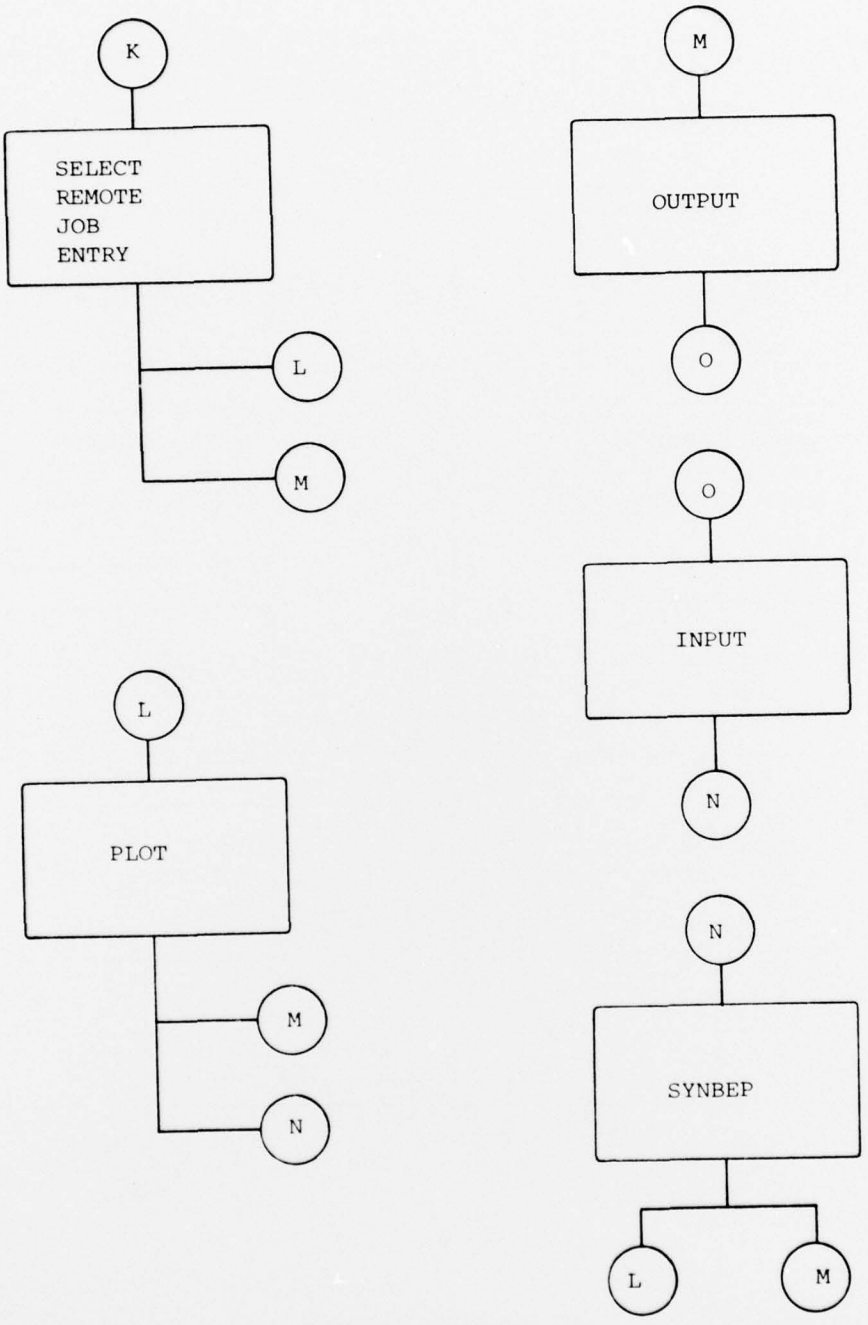
DRT Revision Process



DRT Revision Process



DRT Revision Process



DRT Revision Process

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